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MASK ANALYSIS PROGRAM (MAP) REFERENCE MANUAL

By C. L. Mitchell

M&S Computing, Inc. Huntsville, Alabama 35805

June 23, 1976



Prepared for:

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PREFACE

This document is intended to serve as a User's Manual and a Programmer's Manual for the Mask Analysis Program. The first portion of the document is devoted to the user. It contains all of the information required to execute MAP. The remainder of the document describes the details of MAP software logic. Although the information in this portion is not required to run the program, it is recommended that every user review it to gain an appreciation for the program functions.

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1. INTRODUCTION

In examining software designed specifically for artwork verification and other closely related graphic analysis functions, several major disadvantages become apparent:

- Artwork verification and other analysis processes are generally limited to small designs due to techniques for which execution time and computer memory resources increase out of proportion to an increase in design density or complexity.
- o When artwork analysis techniques are too rigid or too specific, the software is useful for only limited technologies. The software will require constant updating, and eventually become obsolete.
- o If the software requires lengthy and cumbersome input data preparation, or if the input data is an output produced by another program, standalone usage may be prohibited. If the output format is a rigid interface to another program, its usefulness as a standalone program is questionable.

The Mask Analysis Program (MAP) was designed to avoid these pitfalls and to surpass the capability of the single function analysis programs. Two significant principles were applied in the design of MAP.

- o <u>Data Base Simplicity</u> MAP operates on mask data which has been converted from its original form to orthogonal rectangles with identification numbers.
- Maximum User Control MAP processes are completely controlled by a unique command language.

 Among the mask analysis processes which the user may command are: qualitative and quantitative testing of mask areas, modification of masks, creation of new masks, and computation and sorting of mask data.

Among the major features of MAP are the following:

- o Versatility The user is not bound to a specific technology nor to specific mask tests. MAP analysis processes may be applied to a wide range of computer-aided design applications.
- o <u>Multipurpose Processing</u> MAP is not a single function processor restricted to artwork verification. It is also capable of performing the equally important tasks of device identification, nodal analysis, capacitance calculation, and logic equation generation.
- Variable User Interface Input of masks to MAP requires no lengthy or cumbersome formatting or device identification. Input and output data is not restricted to a single format. A number of formats are available. In addition, MAP is structured such that implementation of new formats will require only the replacement of an isolated subroutine.
- o Machine Independence MAP processing is performed on an open-ended data structure basis; i.e., the number and size of masks analyzed are not restricted by available core memory. MAP was written in FORTRAN IV using only the widely compatible statement forms.
- o <u>High-Speed Processing</u> Because of the simplicity of rectangle processing, MAP is capable of greater processing speed than other accepted methods of mask processing.

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2. PROGRAM STRUCTURE AND OPERATION

This section presents a general description of MAP processing flow and a general definition of processing terms which will be referred to in the remainder of the document. Sections 3, 4, and 5 present the details of specific processes for specific circumstances. Appendix A illustrates job setup examples for the actual execution of MAP.

2.1 Flow of Processing

Figure 2-1 illustrates the general flow of MAP processing. As shown, there are two major processes: rectangular refinement and command execution.

Rectangular refinement occurs at the beginning of execution and is the process of reading the graphic input data, converting the data to orthogonal rectangles if necessary, and storing the rectangular data on a file. This is a two pass process. On the first pass, smashing into rectangles occurs. This may consist of breaking orthogonal polygons into rectangles and/or breaking non-orthogonal polygons into thin horizontal rectangle slices which approximate the shape with a degree of accuracy chosen by the user. On the second pass, any necessary scaling or offsetting is performed.

Commands are processed one at a time. Data is read from the mask rectangle file, processing is performed, new data is stored on the rectangle file or an output file, and any user information is printed. Execution continues in this fashion until all of the commands have been processed.

2.2 Definition of Terms

2.2.1 Rectangle Definition and Identification

Figure 2-2 illustrates the MAP definition of an orthogonal rectangle. Six words are required to define a rectangle: two identification numbers, the lower left corner coordinates, and the upper right corner coordinates. Rectangles are processed and stored in this form.

The identification numbers have been provided to allow associations between rectangles to be established and identified by the user. These numbers are referred to in this document as the primary and secondary identifiers and the specific values of each will be discussed in accordance with each command in subsequent sections.

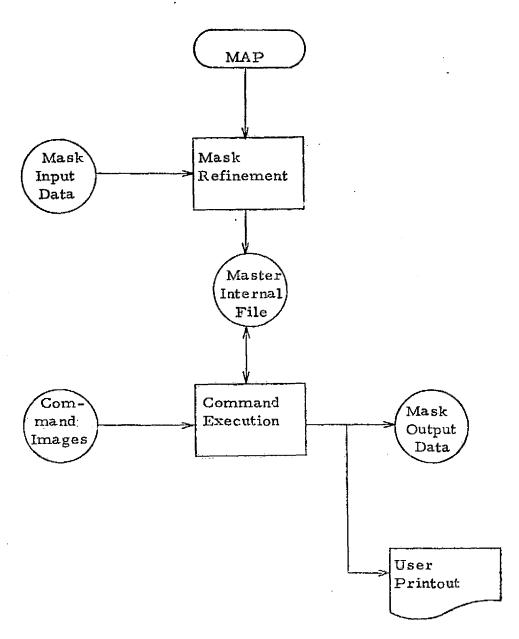
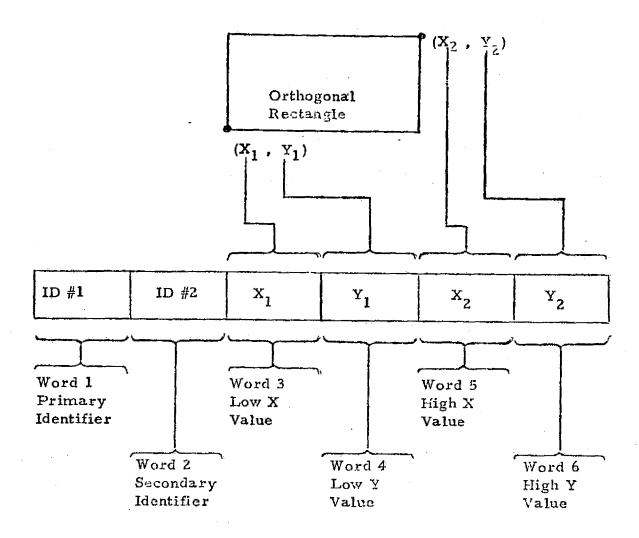


Figure 2-1



. . .

Figure 2-2

2.2.2 General Graphics Terms

Several terms have special connotations with regard to MAP. The term <u>mask</u> refers to the collection of graphic data which is on a single artwork level or which bears a certain qualitative significance. In other words, a mask need not conform to a strict technological mask definition. For example, a mask may be the resulting errors from an artwork test. Internal to MAP, a mask is a collection of rectangles which is stored in one or more records beginning at a mask position on the rectangle file, and which is accessed by a unique 4-character alphabetic name.

The term <u>mask areas</u> must be interpreted somewhat in context. However, in general, an area refers to one or more rectangles on a mask which have a collective significance which is often reflected in the rectangle identifiers.

The term linkage has a special MAP connotation. Rectangles on a mask are linked if they are physically connected. Rectangles on different masks are linked if they intersect or if they are each linked on their own masks to other rectangles which intersect.

GRAPHIC DATA INPUT

The graphic data associated with a set of masks may be described in many ways. One of the significant features of MAP is the wide variety of input data formats which it will accept. MAP will accept masks from mixed formats within the same run. Appendix B details each input format currently accepted. The structure of MAP is such that acceptance of additional formats requires only the addition of a small subroutine to interpret each format.

After a specific format is interpreted by MAP, the data is translated into an internal format allowing the most efficient processing capabilities. This internal format, as discussed in Section 2, is in the form of rectangle definitions.

Most users will probably find this 2-dimensional form quite suitable. However, the facility exists in MAP for handling 1-dimensional data. The user may specify that the input data for a particular run is to be treated as line segments. This requires the same storage space; line end points instead of rectangle diagonal end points are stored. One-dimensional data of this type is readily acceptable to many of the MAP processes. However, there are certain processes which are not meaningful with 1-dimensional data and the program will consider the data 2-dimensional. The user, therefore, should be cautious in selecting meaningful commands when processing linear data.

4. MAP COMMAND FORMATS

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This section is devoted to the description of MAP commands. The MAP command language is the means by which the user initiates mask processing. This approach contributes to the versatility of the program and provides the maximum user control, since processing is performed exactly as commanded.

For a program using this command approach to be versatile, the command language must offer a wide range of capabilities. Table 4-1 is a summary of the commands comprising the high-level MAP language. The commands are listed in several categories:

- o Preprocessing Commands are processed at the beginning of the execution to specify run options and assign names to the input masks.
- o Input/Output Commands are provided to allow the user to conveniently transfer data.
- o Operational Commands direct the performance of a long list of single and double mask operations which result in the creation of new masks.
- o List Processing Commands direct several multiple mask processes which require complex list processing techniques.
- o Dimensional Processing Commands are provided to initiate various dimensional calculations.
- o Control Commands are provided to allow the user to change position in the command string to construct loops and branches in processing.

The user will find that the MAP language contains commands for very complex processes as well as very simple processes. Many of the operational processes, for example, are very basic processes. The user will find that several basic processes are often required to obtain a desired result, and there are often several methods of obtaining the same result. With practice, a user can quickly acquire the ability to set up efficient command strings. The user should not find it disturbing if a particular execution requires several hundred commands. MAP processing speed is very high, particularly for the very basic processes.

MAP COMMAND SUMMARY

COMMAND	DESCRIPTION
Preprocessing Commands:	
OPTN	Option specification
MASK	Input mask identification
Input/Output Commands:	
СОММ	Comment printout
FILE	Special mask output
TEXT	Special text output
FREE	Mask storage release
Operational Commands:	
OPER	Mask operations
SPEC	Mask operation specifications
List Processing Commands:	
TRAC	. Interconnection tracing
BOOL	Boolean equation generation
LIST	List cross-reference
Dimensional Processing Comp	nands:
AREA	Area computation
PERI	Perimeter computation
PARE	Area and perimeter computation
RANG	Range computation
Control Commands:	
SKIP	Unconditional routing
IFNL	Null condition routing

Table 4-1

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This section presents a discussion of each of the command categories and a detailed description of each command format and usage considerations. The commands are input in a basically free format, are read as 80-character records, and are interpreted character-by-character.

The format descriptions which follow illustrate the general form, however, the following points should be noted when coding commands:

- o Command names occupy the first four characters of the command record.
- o Mask names must be alphabetic strings of one to four characters with no internal blanks and must not be the same as any of the MAP command names, operators, specifiers, or qualifiers.
- o All numerical values must be whole numbers. Positive values should not be preceded by a "+" sign.
- o All delimiters (commas, colons, slashes, equal signs, etc.) where specifically illustrated in the format description are required.
- o Where blanks are indicated in the format description, any number of blanks may be entered and any number of blanks may be placed between the command name and the remainder of the command.
- o Characters 73-80 of a command record are not interpreted as part of the command and, therefore, may be used for comments or identification.

4.1 Preprocessing Commands

The preprocessing commands are required for every MAP execution, first the OPTN command and then the required number of MASK commands. These two commands are read only through the command input unit, and should not be included with commands to be read from an alternate command input unit.

4.1.1 OPTN - Option Specification Command

Format:

OPTN p,a,d,f,o,s.

p = 0/1/2/3/4/5/ - degrees of printout.

a = 0/1/ - alternate input command unit, off/on.

d = 0/1/ - normal 2-dimensional data/1-dimensional data.

f = <u>+</u> integer - input scale factor. Positive implies multiplication, negative implies division.

o = 0/1/ - automatic offset, on/off.

s = 0/integer - smash slice height after scaling when applicable.

Description:

The OPTN command is used to specify options which are to apply to an individual MAP run. It is the first command processed.

The user may select one of six degrees of printed output from the printer unit. Table 4-2 indicates the information provided for each degree. A value of 2 or 3 is recommended for most runs.

If an alternate command unit is specified, all commands following the last MASK command will be read from the alternate unit.

One- or two-dimensional data interpretation is in effect for the entire run.

The scale factor indicated is applied after and in addition to any scale factors indicated in the input data file.

Automatic offset adjusts all mask coordinates such that the lowest and leftmost point on any mask is point (0,0). If automatic offset is not specified, offset will occur only if negative coordinate values are encountered in the data.

OPTIONAL INFORMATION OUTPUT

INFORMATION DESCRIPTION	PRINT OPTION
No printout	0
General information messages Error messages File and mask directory at beginning and end of run Command images as processed	1-5
File and mask directory after each process Listing of resultant mask data when PRNT specifier is used or when data is of a list form Timer output after each process	2-5
Listing of command file at the beginning of the run Listing of all resultant mask data	3-5
Basic debug output	4-5
Listing of intermediate processing mask results Extensive debug output	5

Table 4-2

The smash slice height should be specified as zero unless the input data contains non-orthogonal items. In that case, a smash slice height should be specified in accordance with the range in value of the data and the accuracy desired. Very thin slices will result in very accurate approximations but will increase the number of rectangles on the mask and reduce the processing speed. On the other hand, the slice height should not be too large. A rule of thumb is the maximum slice height should not exceed the shortest distance between any non-orthogonal line and any other line which is not directly connected. This will eliminate any discontinuities which could be created in smashing.

4.1.2 MASK - Input Mask Identification Command

Format:

MASK $u, t, s, m_1, \ldots, m_n$

- = integer > 11 mask input logical unit number. On machines which require a FORTRAN DEFINE FILE for a particular format file type, the value of u is restricted to the range of 11-15.
- t = -1/0/1/2/3/4 mask data format type. See Appendix B for complete description.
- s = integer number of levels to skip before accepting input data. For types -1, 3, and 4 it is with respect to the beginning of the file; for types 0, 1, and 2 it is with respect to the current file position.

m₁,..., m_n= names to be assigned to the masks as they are input.

Description:

At least one MASK command is required for MAP execution. It must follow the OPTN command.

Multiple MASK commands are required when: data is to be input from more than one unit, the data consists of mixed formats, or the desired masks cannot be read in a continuous sequential manner from the input device.

The level skip capability is provided to allow inputting portions of mask files. After part of a file is skipped, successive mask levels are accepted until all the assigned names have been used.

4.2 Input/Output Commands

The commands in this category are all associated with input/output operations.

The COMM and FREE commands are primarily provided as a convenience to the user. The FILE and TEXT commands represent the major MAP facility for mask data output.

4.2.1 COMM - Comment Printout Command

Format:

COMM character string

character string = users comment of up to 68 characters to be printed on the listing.

Description:

The COMM command allows the user to document the MAP execution listing. Whenever a COMM command is encountered, the character string contained is printed on the run listing, centered on the page. These comments are also a benefit to the user by helping to maintain order and meaningfulness of the command file or card deck.

4.2.2 FILE - Special Mask Output Command

Format:

FILE u, t, m, l, f

u = 5/6/7/8/9 - output logical unit number.

t = 0/1/2/3- mask data format type. See Appendix B for complete description.

m = name of the mask to be output.

1 = level number on output file. Required only for type 3 format.

f = 1/0 - new file to be started/no new file. Applicable only to type 3 format.

Description:

The FILE command initiates mask coordinate data output according to the format specified by the user. The coordinate data is output as rectangle descriptions. Where the format permits, the rectangle identifiers are included.

4.2.3 TEXT - Special Text Output Command

Format:

TEXT u, t, m, l, f

u = 5/6/7/8/9 - output logical unit number.

t = 0/1/3 - mask data format type. See Appendix B for complete description.

n = 1/2/3 - primary/secondary/both identifiers to be output.

m = name of the mask for which identifiers are output.

1 = level number on output file. Required only for type 3 format.

f = 1/0 - new file to be started/no new file. Applicable only to type 3 format.

Description:

The TEXT command initiates output of rectangle identifiers. Included are the lower left coordinates of each associated rectangle. This type of information is very useful for displaying mask area identification when utilizing a graphics system with a CRT.

4.2.4 FREE - Mask Storage Release Command

Format:

FREE m₁,...,m_n

 m_1, \ldots, m_n = names of the masks to be deleted from the master mask file.

Description:

The master mask file contains space for a specific number of masks. The number of masks which can be contained depends on the file assignment and the dimension of the directory arrays in the particular MAP version. When this number of masks is small due to machine or disk limitations, the user may need to delete masks which are no longer needed for processing, to provide file space for other masks. This is initiated through the FREE command. The program simply erases its directory information for the masks listed, releasing the file space for further use.

4.3 Operational Commands

Two operational commands, OPER and SPEC direct the performance of a number of simple mask operations. The OPER command is used to initiate an operation involving one or two masks, the result of which is the creation of a new mask. The SPEC command is used to define specifications to an operation. It precedes the OPER command of the operation for which the specifications apply.

Because the operations which are available and the specifications which can be applied are numerous, the general forms of the OPER and SPEC commands will be discussed first, each followed by a complete description of the specific forms.

4.3.1 OPER - Mask Operation Command

General Format:

OPER $m_r = obm_1, m_2bq_1, q_2$

m = the name to be given to the mask resulting from the operation.

o = a 4-character operator identifying the operation to be performed.

m, m = the names of the masks involved in the operation.

q₁, q₂ = any qualifiers or options associated with the operation where applicable.

General Description:

The OPER command simply initiates the creation of a new mask from a specified operation on one or two other masks. It is permissible for a mask being operated upon to also be named as the resultant mask,

in which case, the resultant mask will assume the name and the other mask will be lost upon completion of the operation. Table 4-3 is a summary of the operational forms available with the OPER command.

SAME Format:

m = the name of the resultant mask.

m₁ = the name of the mask to which the resultant mask is equated.

SAME Description:

The SAME operation simply creates a mask which is a duplicate of another mask. Unless otherwise specified (by a SPEC command), the identifiers on the resultant mask will be the same as on the original mask.

NGTV Format:

m = the name of the resultant mask.

m₁ = the name of the mask of which the resultant mask is a negative.

NGTV Description:

The NGTV operation creates a mask which is the negative of another mask. The lower boundaries of the resultant mask are zero in both x and y directions. The upper boundaries are the maximum x and y values encoutered during preprocessing of the masks.

Unless otherwise specified (by a SPEC command), the primary and secondary identifiers for all of the rectangles on the resultant mask will be set to one and two respectively.

EDGE Format:

OPER
$$m_r = obm_1bq_1, q_2$$

m = the name of the resultant mask.

o = edge operator:

FDGE - extraction of all edges.

HEDG - horizontal edges only.

VEDG - vertical edges only.

SUMMARY OF OPERATIONS

OPERATOR	MASKS	EUNCTION DEPEOPMED
FORM	INVOLVED	FUNCTION PERFORMED
SAME	1	Equation
NGTV	1	Negation
EDGE HEDG VEDG	1	Edge extraction
EXPN	1	Expansion
PLUS	2	Addition
INTR	2	Intersection
NINT	2	Non-intersection extraction
EXOR	2	Exclusive OR
LINK	1	Single mask linkage
LINK	2	Double mask linkage
NLNK	2	Non-linkage extraction
TWIX HTWX VTWX DTWX	i	Single mask spacing extraction
TWIX HTWX VTWX DTWX	2	Double mask spacing extraction
SPIN	11	z-axis rotation
FLIP	11	x- and/or y-axis rotation
PUSH	1	Offset
SCAL	1	Scaling
WNDW	1	Window restriction
PLAC	2	Cell placement

Table 4-3

m₁ = the name of the mask from which area edges are to be extracted.

q₁, q₂ = optional buried line removal qualifiers. One or two of the following:

SAMI - same primary identifiers.

SAM2 - same secondary identifiers.

SAME - both identifiers the same.

DIF1 - different primary identifiers.

DIF2 - different secondary identifiers.

DIFF - both identifiers different.

EDGE Description:

Any form of the EDGE operation creates a new mask which contains the edges (or sides) of areas (rectangles or groups of rectangles) on another mask. Although the resultant edges are lines, they are stored and processed as widthless rectangles. The user has the option of extracting all edges, horizontal edges only, or vertical edges only by choosing the operator EDGE, HEDG, or VEDG respectively.

If no optional buried line removal qualifiers are specified, the resultant mask contains all of the horizontal and/or vertical edges of every rectangle. The buried line removal qualifiers allow the user to obtain the edges of mask areas (rectangle clusters). If several rectangles are adjacent or overlapping and only their periphery is desired, the internal edges may be eliminated. The line removal qualifiers represent the conditions upon which internal lines will be removed. The conditions are based on the relationships of the primary and secondary identifiers of any two adjacent or overlapping rectangles in question. Figure 4-1 illustrates several examples of EDGE operation results with various line removal qualifiers.

Unless otherwise specified (by a SPEC command), a resultant edge will retain the identifiers of the rectangle from which it was extracted.

EXPN Format:

OPER mr = EXPNbmlbx, y

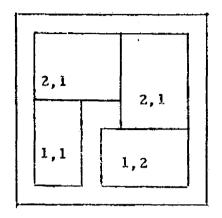
 m_r = the name of the resultant mask.

m, = the name of the mask to be expanded.

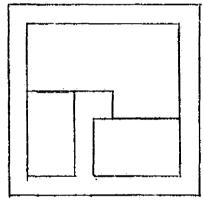
 $x, y = \pm integer expansion values.$

EXAMPLES OF EDGE OPERATION BURIED LINE REMOVAL

Mask A



Mask B - result of OPER B = EDGE A SAME



Mask C - result of OPER C = EDGE A DIF1

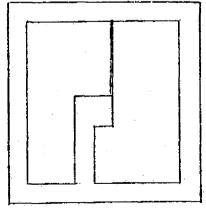


Figure 4-1

EXPN Description:

The EXPN operation creates a new mask which contains the rectangles of another mask expanded by given distances in the x and/or y directions. Negative expansion values will result in size reduction. The overall dimensional change is twice the expansion value; e.g., in the horizontal direction, the left side is shifted left a distance x, and the right side is shifted to the right also by a distance x.

Unless otherwise specified (by a SPEC command), the primary and secondary identifiers will be retained exactly as on the original mask.

Any portion of the resultant mask, which as a result of expansion, falls outside of the first quadrant (positive coordinates) or exceeds the maximum positive x or y limits, will be lost.

The reader will note that this operation is an additive process. For a multiplicative scaling, refer to the SCAL form of the OPER command.

PLUS Format:

OPER $m_r = PLUSbm_1, m_2$

m, = the name of the resultant mask.

m1, m2 = the names of the masks to be combined.

PLUS Description:

The PLUS operation simply creates a new mask which contains all of the rectangles of two other masks. Unless otherwise specified (by a SPEC command), the rectangles will retain their original primary and secondary identifiers.

INTR Format:

OPER $m_r = INTRbm_1, m_2bq_1, q_2$

mr = the name of the resultant mask.

m1, m2 = the names of the masks to be intersected.

q1, q2 = optional intersection qualifiers. One or two of the following:

SAMI - same primary identifiers.

SAM2 - same secondary identifiers.

SAME - both identifiers the same.

DIF1 - different primary identifiers.

DIF2 - different secondary identifiers.

DIFF - both identifiers different.

INTR Description:

The INTR operation creates a new mask which contains rectangles representing the coincidence or intersection of two other masks.

If no qualifiers are specified the resultant mask contains all intersection areas of the two masks. The intersection qualifiers allow the user to specify what is a valid intersection between two rectangles based on some relationship between the rectangle identifiers, as listed above.

Unless otherwise specified (by a SPEC command), a rectangle on the resultant mask will have primary and secondary identifiers respectively reflecting the primary identifier of the rectangle on the first (m₁) mask and the primary identifier of the rectangle on the second (m₂) mask which intersected to form it.

NINT Format:

OPER $m_r = NINTbm_1, m_2bq_1, q_2$

m = the name of the resultant mask.

m₁ = the name of the mask containing the areas to be found exclusive.

m₂ = the name of the mask containing excluded areas.

q,,q = optional intersection qualifiers, see INTR Format.

NINT Description:

The NINT operation creates a new mask which contains all of the areas on the first mask (m_1) which do not intersect the second mask (m_2) . The qualifiers are the same as for the INTR operation.

Unless otherwise specified (by a SPEC command), the resultant rectangles retain the original identifiers.

EXOR Format:

OPER m = EXORóm, m fq, q

m = the name of the resultant mask.

m₁, m₂ = the name of the mask on which rectangle linkages are to be found.

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

q1,q2 = optional intersection qualifiers. See INTR Format.

EXOR Description:

The EXOR operation creates a new mask which contains the exclusive OR of the areas on two other masks. The Boolean equivalent expression is $m_r = m_1 \cdot \overline{m}_2 + m_1 \cdot m_2$. The qualifiers are the same as for the INTR operation.

Unless otherwise specified (by a SPEC command), the resultant rectangles will retain the identifiers from their respective original masks.

Single Mask LINK Format:

OPER $m_r = LINK m_l m_l$

m = the name of the resultant mask.

m₁ = the name of the mask on which rectangle linkages are to be found.

q₁ = optional inter-mask linkage qualifier:

POIN - minimum connection by a point.

LINE - minimum connection by a line.

AREA - minimum connection by an area.

Single Mask LINK Description:

The LINK operation on a single mask creates a new mask containing the same rectangles as on the original mask but with their identifiers modified to reflect connections between rectangles. The resultant secondary identifiers are set equal to the original primary identifiers for each rectangle. The operation locates groups of physically connected rectangles. The rectangles within each group are assigned a new primary identifier which is equal to the lowest original primary identifier of the rectangles within the connected group.

The user may specify the minimum qualifications for a valid physical connection with the qualifiers listed above. If no qualifier is specified it defaults to POIN.

Figure 4-2 illustrates the resulting identification number assignments for each connection qualification for the single mask LINK operation.

EXAMPLE OF THE SINGLE MASK LINK OPERATION

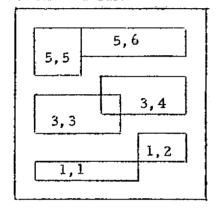
Mask A

5,10

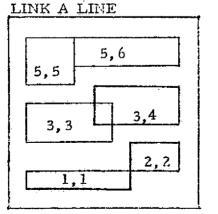
4,10

2,10

Mask B - result of OPER B = LINK A POIN



Mask C - result of OPER C =



Mask D - result of OPER D =

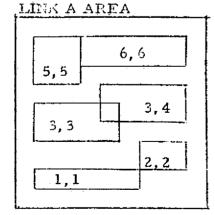


Figure 4-2

Double Mask LINK Format:

OPER $m_r = LINKbm_1, m_2bq_1, q_2$

m, = the name of the resultant mask.

m, = the name of the mask to be linked.

m2 = the name of the mask to which linkage is performed.

q₁ = intra-mask linkage qualifier:

POIN - minimum connection by a point,
LINE - minimum connection by a line.
AREA - minimum connection by an area.

NONE - no intra-mask linkage.

q₂ = optional inter-mask linkage qualifier:

POIN - minimum connection by a point.

LINE - minimum connection by a line.

AREA - minimum connection by an area.

Double Mask LINK Description:

The double mask LINK operation first locates the connected groups of rectangles on the first mask (m_1) in the same manner as in a single mask LINK operation unless otherwise specified $(q_1 = \text{NONE})$. The qualifier q_1 is specified to indicate the conditions of a valid connection for this step.

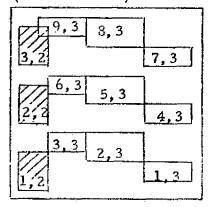
The next step is to locate only those groups of connected rectangles which are connected to any rectangle on the second mask (m_2) . The qualifier, q_2 , indicates what is a valid connection between masks.

The rectangles remaining after the final step constitute the resultant mask. The rectangle secondary identifiers (unless otherwise specified by a SPEC command) will be the original primary identifiers of the rectangles on mask m₁. The rectangle primary identifiers will be set to the primary identifier (unless otherwise specified by a SPEC command) of the first (lowest number) rectangle found on the second mask to which each is linked.

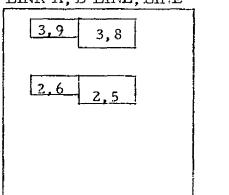
Figure 4-3 illustrates an example of the double mask LINK operation.

EXAMPLES OF THE DOUBLE MASK LINK AND NLNK OPERATIONS

Mask A and Mask B (crosshatched)



Mask C - result of OPER C = LINK A, B LINE, LINE



Mask D - result of OPER D = NLNK A, E LINE, LINE

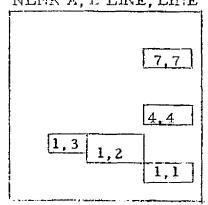


Figure 4-3

NLNK Format:

OPER
$$m_r = NLNKbm_1, m_2bq_1, q_2$$

m = the name of the resultant mask.

m, = the name of the mask to be found not linked.

m₂ = the name of the mask to which no linkage is to occur.

q₁ = intra-mask linkage qualifiers (see Double Mask LINK Format).

q₂ = optional inter-mask linkage qualifiers (see Double Mask LINK Format).

NLNK Description:

The NLNK operation is essentially the reverse of the double mask LINK operation; i.e., to find the rectangles on the first mask which are not linked to the second mask.

The first step is the same as for the double mask LINK operation. The second step is to find only the rectangles or groups of connected rectangles on the first mask (m₁) which are not connected to any rectangle on the second mask (m₂). The qualifiers indicate valid connections, and are identical in form and meaning to those for the double mask LINK.

Unless otherwise specified (by a SPEC command), the rectangle identifiers will be assigned the same as for a single mask LINK, i.e., as resulting from the first step of the operation.

Figure 4-3 illustrates an example of the NLNK operation.

Single Mask TWIX Format:

OPER
$$m_r = obm_1bq_1$$

m, = the name of the resultant mask.

o = spacing operator:

TWIX - horizontal and vertical spacing.

HTWX - horizontal spaces only.

VTWX - vertical spaces only.

DTWX - 'spaces diagonally off rectangle corners.

m₁ = the name of the mask upon which spaces are to be found.

q₁ = optional identifier qualifier:

SAME - same primary identifiers.

DIFF - different primary identifiers.

Single Mask TWIX Description:

Any one of the forms of the single mask TWIX operation is a process of locating spaces between rectangles on a mask. The user may extract horizontal and vertical, horizontal only, vertical only, or diagonal spaces by choosing one of the operator forms: TWIX, HTWX, VTWX, or DTWX, respectively.

The user may further qualify the extracted spaces by specifying a qualifier limiting valid spaces to only those between two rectangles with different primary identifiers. If no qualifier is given all spaces are extracted.

Unless otherwise specified (by a SPEC command), the space rectangles constituting the resultant mask will each have their primary identifier set to the primary identifier of the rectangle on the original mask which was to the left or below it, and each secondary identifier will be set to the primary identifier of the rectangle on the original mask which was to the right or above it.

Figure 4-4 illustrates examples of single mask TWIX operations.

Double Mask TWIX Format:

OPER mr = obm1, m2 bq1

m = the name of the resultant mask.

o = spacing operator:

TWIX - horizontal and vertical spaces.

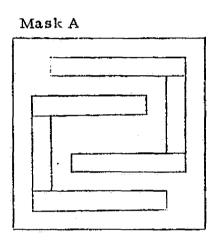
HTWX - horizontal spaces only.

VTWX - vertical spaces only.

DTWX - spaces diagonally off rectangle corners.

m₁, m₂ = the names of the masks between which spaces are to be found.

EXAMPLES OF SINGLE MASK TWIX OPERATION FORMS



Mask A (broken lines) and Mask B - result of OPER B = HTWX A

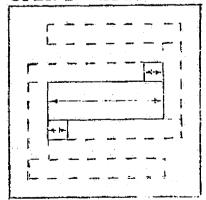
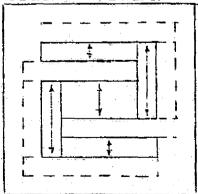


Figure 4-4

Mask A (broken lines) and Mask C - result of OPER C = VTWX A



q, = optional identifier qualifier:

SAME - same primary identifiers.

DIFF - different primary identifiers.

Double Mask TWIX Description:

The forms of the double mask TWIX operation are the same as the single mask TWIX forms except that spaces extracted are between the rectangles of two masks; i.e., as would be seen if the two masks were overlayed. Only spaces between rectangles of different masks are extracted.

The identifier qualifier has the same meaning as for the single mask TWIX operation.

Unless otherwise specified (by a SPEC command), the space rectangles constituting the resultant mask will each have primary and secondary identifiers corresponding to the primary identifiers of the rectangle on the first mask (m₁) and the rectangle on the second mask (m₂), respectively, between which the space was located.

SPIN Format:

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OPER $m_r = SPINbm_1bx_r, y_r, q$

m; = the name of the resultant mask.

m₁ = the name of the mask to be rotated.

 x_r, y_r = integers > 0 - coordinates of the center of rotation.

q = 1/2/3 - the number of quadrants of rotation.

SPIN Description:

The result of the SPIN operation is the original mask rotated in the x-y plane about the point (x_r, y_r) q quadrants in the clockwise direction.

Unless otherwise specified (by a SPEC command) the resultant rectangle identifiers are the same as on the original mask.

Any portion of the mask, which, as a result of the SPIN operation, falls outside of the first quadrant (positive coordinates) or exceeds the maximum positive x or y limits, will be lost.

FLIP Format:

OPER $m_r = FLIPbm_1bx_m, y_m$

m = the name of the resultant mask.

m, = the name of the mask to be mirrored.

x = positive integer - x mirroring axis, or no x · · · mirroring if zero.

y = positive integer - y mirroring axis, or no y mirroring if zero.

FLIP Description:

The result of the FLIP operation is the mirroring of a mask about a line x = x and/or about a line $y = y_m$. Unless otherwise specified (by a SPEC command), the resultant rectangle identifiers are the same as on the original mask.

Any portion of the mask which, as a result of mirroring, falls outside of the first quadrant (positive coordinates) or exceeds the maximum positive x or y limits will be lost.

PUSH Format:

OPER m = PUSHbm bx , y

m, = the name of the resultant mask.

m, = the name of the mask to be offset.

x = integer - x direction offset value.

y = integer - y direction offset value.

PUSH Description:

The result of the PUSH operation is the offsetting of the original mask by a value of x_0 in the x direction and y_0 in the y direction.

Unless otherwise specified (by a SPEC command), the resultant rectangle identifiers are the same as on the original mask.

Any portion of the mask which, as a result of the offset, falls outside of the first quadrant (positive coordinates) or exceeds the maximum positive x or y limits, will be lost.

SCAL Format:

OPER m_r = SCALbm₁bx_s, y_s

m = the name of the resultant mask.

m, = the name of the mask to be scaled.

x = integer scale factor in the x direction. Negative values indicate division. A zero is interpreted as no scaling.

y = integer scale factor in y direction. Negative values indicate division. A zero is interpreted as no plant.

SCAL Description:

The result of the SCAL operation is the scaling of the original mask by given factors in the x and/or y directions. The reader will note that this is a multiplicative process. For an additive expansion or reduction see the EXPN form of the OPER command.

Unless otherwise specified (by a SPEC command), the resultant rectangle identifiers are the same as on the original mask.

Any portion of the mask which, as a result of the scaling process, falls outside of the first quadrant (positive coordinates) or exceeds the maximum positive x or y limits will be lost.

WNDW Format:

OPER $m_r = WNDWbm_1bx_1, y_1, x_2, y_2$

m = the name of the resultant mask.

m₁ = the name of the mask to be windowed.

x₁, y₁ = integers - the lower left corner coordinates of the rectangular window.

x₂, y₂ = integers - the upper right corner coordinates of the rectangular window.

WNDW Description:

The result of the WNDW operation is a mask which contains only the areas of the original mask which fall within the range of a rectangular window. The window is specified by its lower left corner point (x_1, y_1) and its upper right corner point (x_2, y_2) .

Unless otherwise specified (by a SPEC command), the resultant rectangle identifiers are the same as on the original mask.

PLAC Format:

OPER mr = PLAC & m1, m2

m, = the name of the resultant mask.

m₁ = the name of the mask containing the cells to be placed.

m₂ = the name of the mask containing placement location of the cells.

PLAC Description:

The PLAC operation creates a mask which is the result of placing the cells defined by the first mask (m_1) in the positions defined by the second mask (m_2) .

Unless otherwise specified (by a SPEC command), the resultant placed cell rectangle identifiers will be the cell identifiers as on the first mask (m₁).

Any portion of the mask which, as a result of the placement process, falls outside of the first quadrant (positive coordinates) or exceeds the maximum positive x or y limits will be lost.

The mask containing the cell description (m₁) must be a valid cell mask. The mask containing the cell placement location (m₂) must be a valid placement mask. Refer to Appendix B for the data types and format descriptions of these special mask forms.

4.3.2 SPEC - Mask Operation Specification Command

General Format:

SPEC
$$s_1, s_2, \ldots, s_n$$

 $s_1, s_2, \dots, s_n = specifications list.$

General Description:

The SPEC command is used to define specifications to be applied to the operations defined by OPER commands. Table 4-4 is a summary of the available specification forms.

Any number or combination of specifications may be defined for a single operation. Multiple SPEC commands may be used where necessary. All SPEC commands must directly precede the OPER command for the operation to which they apply. Where conflicting or redundant specification types are contained in a SPEC command, the program accepts the last one encountered as valid. Once the operation has been performed, the program cancels the specifications.

In the following description of the individual specifier forms, the formats will each be illustrated as if they were used alone. Where several specifications are defined they are separated by commas as shown in the above general format.

Any rectangle identifier modifications as indicated by the specifiers E and R are performed in the very last step of any operation. The modifications are based on a previous identifier status. This identifier status is the default status and depends upon the operation form. The defaults are contained in the description of each OPER form in the preceding portion of this chapter.

PRNT Specifier Format:

SPEC PRNT

PRNT Specifier Description:

The PRNT specifier simply indicates the result of the operation is to be printed by the listing device. The six-word rectangle descriptions are printed one per line. The result is a six column list where the columns contain primary identifiers, secondary identifiers, low x-coordinates, low y-coordinates, high x-coordinates, high y-coordinates.

The user must be sure that the proper print option value has been specified by the OPTN command, as the PRNT specifier may be overridden.

TEMP Specifier Format:

SPEC TEMP

TEMP Specifier Description:

The TEMP specifier indicates that the result of the operation is to be discarded upon the completion of the operation. The TEMP specifier is obviously

SUMMARY OF OPERATIONAL SPECIFICATIONS

SPECIFIER FORM	APPLICATION TO OPERATIONAL RESULT	
PRNT	Printed output	
TEMP	Temporary storage	
MIN	Minimum dimensional restrictions	
MAX	Maximum dimensional restrictions	
E	Identifier equation	
R	Identifier replacement	
s	Identifier starting number	
I	Identifier incrementing value	

Table 4-4

meaningless unless the output is printed. If it is used alone the operation will be wasted unless a PRNT specifier is defined or an appropriate print option was given in the OPTN command. This specifier is useful to avoid accumulating masks which only need to be printed.

MIN Specifier Format:

SPEC MINd = v

d = 1- character direction indicator:

A - all (x and y) directions.

X - x direction.

Y - y direction.

L - length.

W - width.

R - radial.

v = integer minimum dimension value.

MIN Specifier Description:

The MIN specifier allows the user to define the minimum acceptable dimensions of resultant mask areas. If some portion of an area does not meet the minimum dimension requirements, that portion will be deleted from the result. The minimum dimension restriction can be applied in any of the directions indicated above. Table 4-5 indicates which of the directions are valid for which operation forms.

MAX Specifier Format:

SPEC MAXd = v

d = 1-character direction indicator.

A - all (x and y) directions.

X - x direction.

Y - y direction.

L - length.

W - width.

R - radial.

v = integer maximum dimension value.

MIN AND MAX SPECIFIER'S APPLICATION TO OPERATIONS

SPECIFIER FORMS	APPLICATION TO OPER FORMS	
MINA, MAXA	Applicable to any OPER form.	
MINX, MAXX	Applicable to any CPER form.	
MINY, MAXY	Applicable to any OPER form.	
MINL, MAXL	Applicable to all EDGE forms to limit line lengths. Applicable to single and double mask TWIX, HTWX, and VTWX forms to limit the length of spacing runs.	
MINW, MAXW	Applicable to single and double mask TWIX, HTWX, and VTWX forms to limit the spacing distance.	
MINR, MAXR	Applicable to single and double mask DTWX forms limiting the diagonal spacing distance.	

Table 4-5

MAX Specifier Description:

The MAX specifier allows the user to define the maximum acceptable dimensions of resultant mask areas. If some portion of an area exceeds the maximum dimension requirements, that portion will be deleted from the result. The maximum dimension restrictions can be applied in any of the directions listed. Table 4-5 indicates which of the directions are valid for which operation forms.

E Specifier Format:

SPEC Ei @i

i = the identifiers to be equated:

1 - primary.

2 - secondary.

ip = the previous identifier to which the new identifier is being equated:

1 - primary.

2 - secondary.

E Specifier Description:

The E specifier is used to cause the resultant rectangle primary and/or secondary identifiers to be equated to the previous primary or secondary identifiers. A complete swap of identifiers is specified by E1@2 and E2@1.

R Specifier Format:

SPEC Rig@i

i = the identifiers to be replaced:

1 - primary.

2 - secondary.

ip = the condition of the previous identifiers as the basis for incrementing the identifiers being replaced:

- 0 unconditional replacement, identifier incremented for each rectangle.
- 1 increment on a change in previous primary identifiers.

- 2 increment on a change in previous secondary identifiers.
- 3 increment on a change in either the primary or secondary identifiers.

R Specifier Description:

The R specifier is used to cause the resultant rectangle primary and/or secondary identifiers to be replaced based on some condition of the previous status of the identifiers.

When an R specifier has been given, the functional portion of the operation is performed normally. Upon completion, the resultant rectangles are arranged in an ordered list. The ordering is based first on the lowest primary identifier; when they are equal the next consideration is the lowest secondary identifier.

The replacement of identifiers is based on the position of the rectangles in the ordered list. An unconditional replacement ($i_p = 0$) is simply the assignment of new identifiers in sequential fashion through the list, incrementing the identifier for each rectangle. For the other replacement types ($i_p = 1$, 2, or 3) identifiers are replaced in the same sequential fashion through the list except the identifier value is only incremented upon conditions of change in previous identifiers. For $i_p = 1$ incrementing occurs when a new primary identifier is found, for $i_p = 2$ incrementing occurs when a new secondary identifier is found, and for $i_p = 3$ incrementing occurs when either a new primary or secondary has been found.

The S and I specifiers discussed later in this section are used in conjunction with the R specifier to define the starting value and the increment. If the S or I specifiers are not given, the starting value defaults to one and the increment defaults to one.

S Specifier Format:

SPEC Si_r@#bv, or

SPEC Sir@iltml

ir = the identifier being replaced for which the starting value is being defined:

1 - primary.

2 - secondary.

v = positive integer identifier starting value.

i₁ = the type of identifier to be looked up for use in computing starting value:

1 - primary.2 - secondary.

m₁ = the name of the mask for which the highest i₁ identifier is looked up.

S Specifier Description:

The S specifier is used in conjunction with an R specifier to define the starting identifier to be used in the identifier replacement process.

There are two forms of the S specifier as shown above. The first form allows the user to specify a constant starting value. The second form allows the user to have a starting value calculated based upon the highest identifier found on another mask. The program looks up the highest type i_1 (primary or secondary) identifier assigned to any of the rectangles on the desired mask m_1 . The program then adds one increment to this value to get the starting value for replacement.

When an R specifier is used without an S specifier the starting value defaults to one. When an S specifier is used without an R specifier, it is ignored.

Caution should be exercised in choosing a starting value. If an identifier exceeds the maximum integer value allowed for the particular computer, the run may produce erroneous results or may abort.

I Specifier Format:

SPEC Ii @#bv

ir = the identifier being replaced for which the replacement incrementing value is being defined:

1 - primary.2 - secondary.

 $v = integer increment \geq 0$.

I Specifier Description:

The I specifier is used in conjunction with an R specifier to define the value by which replacement numbers are changed for each time they are incremented. The increment value is simply given as a constant integer value. When an R specifier is used without an I specifier the increment value defaults to one. When an I specifier is used without an R specifier, it is ignored.

Caution should be exercised in choosing large increment values. If an identifier exceeds the maximum integer value allowed for the particular computer, the run may produce erroneous results or may abort.

4.4 List Processing Commands

Three special list processing commands are provided for the MAP user. These commands direct complex multiple mask processes:

- o interconnection tracing (TRAC),
- o Boolean equation generation (BOOL), and
- list cross-referencing (LIST).

These three commands have the same general format. The specific format for each is presented in the following sections. In all cases where the command definition becomes lengthy, it may be divided among several command records. In this case, the command string must be divided between items and an "*" must appear as the 72nd character on each record except the last.

4.4.1 TRAC - Interconnection Trace Command

Format:

TRAC $/i_1/i_2/.../i_n/$

/in/ =nth item in the string, of the form /mn:ma,...mi/.

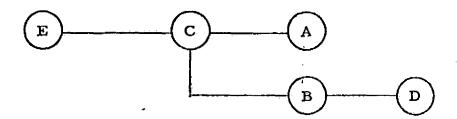
m_n =the name of the mask involved in the trace (reference mask).

 m_a - m_i =the names of the masks which connect directly to the reference mask

Description:

The purpose of the TRAC process is to locate all interconnections (intersections) between a number of levels of masks. The result of this complex linkage process is the reassignment of rectangle identifiers to reflect all of the interconnections among the given masks.

The masks involved and their interconnection possibilities can be expressed as a connection tree. The tree is merely a graphic description of those masks which may be connected through intersection. The following illustration is an example of a connection tree of masks A through E.



This is interpreted: mask A connects to mask E if there is some area on mask A which intersects some area on mask C which intersects mask E, or is connected to another area on mask C which intersects mask E, and so on. If this condition exists then all of the areas on masks E, C, and A which contribute to this pathway, or node, will be given the same primary identification number.

The user represents the tree structure in the TRAC commands by indicating each mask name and the names of each mask to which it may immediately connect. For the above tree, the TRAC command might be represented as:

i.e., E connects to C, C connects to A, B, and E, and so on. The masks in the connection tree may be expressed in any order in the TRAC command, and the connection path identifier assignments will be based on that order.

The user should examine the primary identifiers of the rectangles of the masks involved before commanding execution of TRAC. Any rectangles with equal primary identifiers will be considered as the same node. If this is to be avoided, the primary identifiers on all the masks involved should be made unique. This may be done with a proper SPEC command preceding a SAME operation equating a mask to itself.

Appendix C illustrates a simple example of an electrical nodal trace using the TRAC command.

4.4.2 BOOL - Boolean Equation Generation Command

Format:

BOOL $/u/i_1/i_2/.../i_n/$

u = 5/6/7/8/9 - logical unit to which Boolean data is to be written.

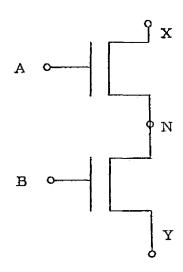
m_n = the name of a mask for which Boolean equations are to be generated (reference masks).

- ma-mi = the names of the masks from which respectively each of i minterms may be derived for each item on the reference mask. If a mask name is preceded by the character "" that mask's minterms will be inverted (NOTed).
- s = 0/1 indicating a constant off or on state respectively.

Description:

The BOOL command process creates a list of Boolean equations which describes some interaction between masks, i.e., the status of some mask item as controlled by the status of other mask items. For example, the status of operation (ON/OFF) of a lightbulb may depend on the status of a switch and the status of voltage on the line; or the status of pipeline flow may depend on the status of a valve and status of fluid in the lines.

The equation generation process initiated by the BOOL command might best be described by a detailed example. A specific application for computeraided-design is that of describing the ON/OFF logic state of each source (or drain) node in terms of the states of other nodes controlling it. The source (or drain) node state of a transistor is controlled by the state of its gate node and its drain (or source) node. The status of a node may be controlled by more than one transistor as shown below.



The status of node N is not only controlled by the states of nodes A and X, but also by the states of nodes B and Y. If the transistors are P-channel the Boolean expression for the status of node N is:

N = X AND NOT A OR Y AND NOT B,

if the transistors are N-channel the expression is:

N = X AND A OR Y AND B,

where each transistor contributes a minterm (e.g., X and A) to the expression. The equation generation process locates all the nodes controlling each node and generates the Boolean expression. The user need only specify the masks on which the minterms are located. Of course, there are nodes which have a constant On or OFF status, i.e., power and ground.

The equation generation process for CMOS requires the following masks to be identified:

-P guard band (PG)

- where the primary sequence numbers are node identifications. Each node on this mask is grounded (0).

-N guard band (NG)

where the primary sequence numbers are node identifications. Each node on this mask is connected to power (1).

-P sources/drains (PSD)

-P gates (PGM)

-N sources/drains (NSD)

-N gates (NGM)

where the primary sequence numbers are devices and secondary sequence numbers are nodes.

Thus, the BOOL command is expressed:

BOOL /u/PG:0/NG:1/PSD:PSD,'PGM/NSD:NSD,NGM/

where each item is the mask name of the node and mask name of its minterm components. The sign " " preceding the mask name PGM indicates that each minterm part located from that mask is to be a NOT state in the Boolean expression.

The Boolean expressions are printed out if an appropriate print option was specified in the OPTN command. The identifier data used to construct the expressions is written to the specified logical unit. Section 5.2 explains the format of this output.

4.4.3 LIST - List Cross-Reference Command

Format:

LIST $/u/i_1/i_2/.../i_n/$

u = 5/6/7/8/9 - logical unit to which the cross-reference lights to be written.

/in/ = nth item in the string, of the form /m:ma, mb,...,mi/...
where:

m_a-m_i - the names of up to three masks contribute to the cross-reference list.

Description:

The LIST process performs a cross-reference on the rectangle identifiers on several masks. Each item contains the name of the reference mask m and a list of associated masks m -m;. The process creates a list where each entry (which corresponds to one unique primary/secondary identifier pair on mask m contains the following:

0	word 1	-	m rectangle primary identifier.
o	word 2	<u>-</u>	m rectangle secondary identifier.
O	word 3	-	m rectangle secondary identifier which has the same primary identifier (word 1).
o	word 4- word i+2	-	same as word 3 for musks mb-mi

o last word - the item number n, (position in LIST command).

When there is more than one item specified in the command, the final list is created by combining and ordering all of the entries from each item's list.

The final cross-reference is written to the specified logical unit. Section 5.2 explains the details of this format. If an appropriate print option was specified in the OPTN command, the list will also be printed.

4.5 Dimensional Processing Commands

Several commands are provided for the user to direct dimensional computation process: areas, perimeters, and ranges. The result of any of these processes is a list of the numeric result of the particular computation.

The following pages describe each of the computations and the format of each command. In all cases, the resultant values are listed in scientific notation: a value times a power of ten. For simplicity only the value and exponent are listed.

4.5.1 AREA - Area Computation Command

Format:

AREA u, m, f

u = 5/6/7/8/9 - logical unit to which area data is to be written.

m = the name of the mask for which rectangle areas are to be computed.

f = + integer factor # 0 to be applied to the final result.

Negative values imply division.

Description:

The result of the AREA computation is a list of the areas (length x width) of the rectangles on the mask, adjusted by the given factor. The list is printed in four columns (if an appropriate print option was specified in the option command): primary identifiers, secondary identifiers, area value, and exponent of ten multipliers. The list is written to the specified logical unit in the format described in Section 5.2.

4.5.2 PERI - Perimeter Computation Command

Format:

PERI u, m, f

u = 5/6/7/8/9 - logical unit to which perimeter data is to be written.

m = the name of the mask for which the rectangle perimeters are to be computed.

f = + integer factor \(\neq 0 \) to be applied to the final result. Negative values imply division.

Description:

1

The result of the PERI computation is a list of the perimeters of the rectangles on the mask, adjusted by the given factor. The list is printed in four columns (if an appropriate print option was specified in the option command): primary identifiers, secondary identifiers, perimeter values, exponent of ten multiplier. The list is written to the specified logical unit in the format described in Section 5.2.

4.5.3 PARE - Area and Perimeter Computation Command

Format:

PARE u, m, fa, fp

u = 5/6/7/8/9 - logical unit to which area and perimeter data is to be written.

m = the name of the mask for which the rectangle areas and perimeters are to be computed.

 $f_a = \frac{+ \text{ integer factor } \neq 0 \text{ to be applied to the final area result.}}{\text{Negative values imply division.}}$

 $f_p = \frac{+ \text{ integer factor } \neq 0 \text{ to be applied to the final perimeter result.}}{\text{Negative values imply division.}}$

Description:

The result of the PARE computation is simply a combination of the AREA and PERI computations. The list is printed in six columns (if an appropriate print option was specified in the option command): primary identifier, secondary identifier, area value, exponent of ten, perimeter value, exponent of ten. The list is written to the specified logical unit in the format described in Section 5.2.

4.5.4 RANG - Range Computation Command

Format:

RANG u, m, f, f

u = 5/6/7/8/9 - logical unit to which range data is to be written.

m = the name of the mask for which the rectangle x and y ranges are to be computed.

 $f_{x} = \frac{+ \text{ integer factor } \neq 0 \text{ to be applied to the final } x \text{ range result.}$ Negative values imply division.

 $f_y = \frac{+ \text{ integer factor } \neq 0 \text{ to be applied to the final y range result.}}{\text{Negative values imply division.}}$

Description:

The result of the RANG computation is a list of the $x(x_2 - x_1)$ and $y(y_2 - y_1)$ ranges of the rectangle on the mask. The list is printed in six 4-40

columns (if an appropriate print option was specified in the option command): primary identifier, secondary identifier, x range value, exponent of ten, y range value, exponent of ten. The list is written to the specified logical unit in the format described in Section 5.2.

4.6 Process Control Commands

Several commands have been provided to allow the user to control the manner in which the total command file is processed. The commands allow the user to have commands unconditionally skipped, or routing in the command file to occur based on a null mask condition.

With practice, a user will quickly learn to set up complex loops and branches in the command file where necessary. This capability also provides for reduction in run times where processes are only useful for non-null masks. The masks may be tested for a null condition and blocks of commands may be skipped if a null is found.

4.6.1 SKIP - Unconditional Routing Command

Format:

SKIP n

 $n = \pm integer - number of commands to skip.$

Description:

The SKIP command directs the program to move forward or backward in the command file. The command file is positioned to next read the nth command following (+) or preceding (-) the SKIP command.

4.6.2 IFNL - Null Condition Routing Command

Format:

IFNL m,n

m = name of the mask to be tested for null condition.

n = + integer - number of commands to skip...

Description:

The IFNL commands direct the program to test for a null condition of the given mask, and if null, to move forward or backward in the command file. When this occurs the command file is positioned to next read the nth command following (+) or preceding (-) the IFNL command.

5. MAP OUTPUT

Several forms of data output are provided by MAP. The two major categories of output are informational output and mask data output. The following pages describe these output forms in detail.

5.1 Informational Printout

MAP informational output is sent entirely to the listing device. Informational output includes page headings, tables, command images, and messages documenting a particular MAP run. The degree of printout is optional as indicated in Table 4-2. The general form of the headings and tables is illustrated in the sample run listing given in Appendix C. Messages associated with abnormal processing conditions are listed in Table 5-1.

When any special debug executions are necessary, the user may specify a print option value of 4 or 5 on the OPTN command. Debug printout consists of single line strings of specific program variable values. This printout has been implemented for selected subroutines and generally occurs on entering or exiting the routine. The debug printout is divided into two categories: basic and extensive. The basic debug printout occurs at significant points in the processes. The extensive debug printout occurs in repeatedly-used routines and may produce a lengthy listing. A print option value of 4 yields only the basic form, a value of 5 yields both forms. Table 5-2 lists the subroutines where printout may occur and a description of the significance of the processing point where the line is printed. The reader may refer to the source listing for the names of the actual variables being printed.

5.2 Mask Data Output

The mask data output includes any type of data directly related to mask rectangle coordinates or identifiers.

The simplest form of this type is a printed listing of mask coordinates and identifiers. As previously mentioned, this is controlled by the print option of the OPTN command and the PRNT specifier of the SPEC command, for OPER commands.

Another output form for mask coordinates and identifiers is via the FILE and TEXT commands to secondary storage devices. The formats available are generally the same as for originally inputting mask data to MAP. Appendix B describes each format in detail. The masks involved in these commands will also be printed when the print option is greater than 2.

ABNORMAL PROCESSING CONDITION MESSAGES

MESSAGE	INTERPRETATION
# FATAL ERROR # ´ CONDITION 1	The first command was not an OPTN command. The execution is terminated.
# FATAL ERROR # CONDITION 2	No MASK command was encountered immediately following the OPTN command. The execution is terminated.
# WARNING # CONDITION 3	A command has been encountered which does not contain a proper command type name as the first four characters. The command is ignored.
# WARNING # CONDITION 4	A command format error is present disabling complete interpretation of the command. An attempt is made to execute the command as it was interpreted.
# ERROR # CONDITION 5	A command format error is present preventing any meaningful interpretation of the command. The command is ignored.
# ERROR # CONDITION 6	No space is available on the mask file to write another intermediate or resultant mask. Execution of the command is terminated.
# WARNING # CONDITION 7	A mask needed for a process is not listed in the mask directory. The mask is assumed to be null. This condition may often occur for valid reasons since null masks are not listed in the mask directory. However, the user should check the spelling of the names given in the command whenever receiving the message.

Table 5-1

ABNORMAL PROCESSING CONDITION MESSAGES (continued)

MESSAGE	INTERPRETATION
# WARNING # CONDITION 8	An intermediate result or a final resultant mask is null. This is a valid condition often encountered in MAP processing. When a resultant mask is null, this message is followed by a null mask message printed at the end of the command processing.
# ERROR # CONDITION 9	An invalid logical unit number has been specified in a command. Execution of the command is terminated.
# WARNING # CONDITION 10	An error has occurred in reading a command. An attempt is made to read the next command.
# WARNING # CONDITION 11	An error has occurred in writing mask data to an output device. An attempt is made to continue execution.
# WARNING # CONDITION 12	An error has occurred in reading mask data from an input device. An attempt is made to continue execution.

Table 5-1 (continued)

DEBUG PRINTOUT

SUBROUTINE		DESCRIPTION	
OP1		Processing path flags are printed preceding a single mask process step.	
OP2		Processing path flags are printed preceding a mask multiplying process step.	
OP3		Processing path flags are printed preceding a simple multi-pass processing step.	
OP4	:• :	Processing path flags are printed preceding a complex multi-pass processing step. Pass flags are printed at the beginning of each pass.	
SMASH		Mask parameters are printed preceding the first pass of input processing for an input mask.	
101		The input mode is printed preceding input of type -1 mask data. This is available only using a print option value of 5.	
, I01A	·	The input mode is printed preceding input of type 0 mask data. This is available only using a print option value of 5.	
		The input mode is printed preceding input of type I mask data. This is available only using a print option value of 5.	
I01C	·	The input mode is printed preceding input of type 2 mask data. This is available only using a print option value of 5.	
101D	,	The input mode is printed preceding input of type 3 mask data. This is available only using a print option value of 5.	
101E		The input mode is printed preceding input of type 4 mask data. This is available only using a print option value of 5.	

Table 5-2

DEBUG PRINTOUT (Continued)

SUBROUTINE	DESCRIPTION	
104	Input and mask parameters are printed follow- ing the reading of a record from the mask file.	
105	Output and mask parameters are printed fol- lowing the writing of a record to the mask file.	
ORDER1	The entry data and ordering flags are printed following the entry of an item into an ordered list. This is available only using a print option value of 5.	
ORDER2	Ordering flags are printed printed preceding the final process of sequencing an ordered list.	
ORDER3	Ordering flags are printed preceding the final process of ordering large lists.	
ORDER4	A pattern identifier is printed preceding the process of setting up an ordering priority pattern.	
воок1	Mask parameters are printed following the location of a mask in the mask directory.	
воок2	Mask parameters are printed following the deletion of an entry in the mask directory.	
GEOM	Testing parameters are printed at the beginning of each step in a dimensional testing process.	

Table 5-2 (Continued)

Another method of output for mask data is via the commands: BOOL, LIST, AREA, PERI, PARE, and RANG. These output forms are not strictly rectangle coordinates and identifiers, but are other forms of mask data which may be of use for more than casual informational purposes. In all cases, the results of these processes are printed when the print option is greater than 1. In addition, the resulting lists will be output to a secondary storage device. The records output to the device contain the same numeric data as is printed in type 0 output format. Refer to Appendix B for format details.

PROGRAM STRUCTURE

MAP FORTRAN code is in the form of a main program and a number of subprograms. The main program is organized into many small "inline routines." These inline routines are simple sections of code in the main program which are set apart by comments and specific statement label ranges. These inline routines represent specific processes; overall program flow, command processing, and operation forms.

Table 6-1 is a list of each of the inline routines and a brief functional description. Table 6-2 describes each of the actual FORTRAN subprograms. All of the subprograms are FORTRAN subroutines unless otherwise noted in the table. Further information regarding routine functions can be gained from the liberal comments in the MAP source listing. The details of the calling structure of these routines and subprograms are presented in Appendix D.

Although the core requirement for MAP is minimal, overlaying may be necessary on machines of very limited core resources. MAP is structured so that it may be readily overlayed. Figure 6-1 illustrates a recommended overlay structure. With this structure a maximum of about 65% of the program procedure can be resident at any time.

MAIN PROGRAM INLINE ROUTINE DESCRIPTIONS

NAME	DESCRIPTION		
Program Flow Routines:			
INIT	Program initialization		
ORTHO	Mask input and orthogonal refinement		
COMMIE	Command interpretation and execution		
FINIT	Normal program termination		
Command and Processing Rou	itines:		
COMM	User comment output		
FILE	Coordinate storage		
TEXT	. Identifier storage		
FREE	Mask storage release		
OPER	Operation execution		
SPEC	Operational specifications setup		
TRAC	Nodal trace execution		
BOOL	Boolean equation generation		
LIST	Special list processing		
AREA	Area computation		
PERI	Perimeter computation		
PARE	Area and perimeter computation		
RANG	Range computation		
SKIP	Unconditional command file repositioning		
IFNL	Null mask condition command file repositioning		

Table 6-1

MAIN PROGRAM INLINE ROUTINE DESCRIPTIONS (continued)

NAME	DESCRIPTION			
Operational Processing Ro	outines:			
SAME	Equation			
NGTV	Negation			
EDGE	Edge extraction			
EXPN	Expansion			
PLUS	Addition			
INTR	Intersection			
NINT	Non-intersection extraction			
EXOR	Exclusive OR			
LINKI	Single mask linkage			
LINK2	Double mask linkage			
NLNK	Non-linkage extraction			
TWIX1	Single mask spacing extraction			
TWIX2	Double mask spacing extraction			
SPIN	z-axis rotation			
FLIP	x-axis and/or y-axis mirroring			
PUSH	Offset			
SCAL	Scaling			
WNDW	Window extraction			
PLAC	Cell placement			

Table 6-1 (Continued)

SUBPROGRAM DESCRIPTIONS

NAME	DESCRIPTION	
OP1	Single mask processing	
OP2	Double mask processing with multiplexed input	
OP3	Multiple pass double mask processing with repetitive secondary input	
OP4	Multiple pass double mask processing with repetitive primary input	
SMASH	Orthogonal smash processing	
101, 101A, 101B, 101C, 101D, 101E	User data input	
102	Command data input and output	
103	Command data decoding	
104	Binary mask data input	
105	Binary mask data output	
106A, 106B, 106C, 106D	User data output	
107	Normal user message printout	
108	Error message printout	
ORDER1	Ordered list item entry	
ORDER2	Ordered list sequencing	
ORDER3	Large list ordering	
ORDER4	Ordering priority pattern setup	
ORDER5	Ordered identifier replacement	

Table 6-2

S\JBPROGRAM DESCRIPTIONS (continued)

NAME	DESCRIPTION	
BOOK1	Mask directory entry location	
BOOK2	Mask directory entry deletion	
GEOM	Minimum and maximum dimension testing	
DEPEND	Isolation of machine dependent code	
LOCATN	Mask file record address calculator (function)	

Table 6-2 (continued)

RECOMMENDED OVERLAY STRUCTURE

,	OP1 (6%)	
	OP2 (2%)	
	OP3 (5%)	
MAIN (24%) Subprograms not overlayed (32%)	OP4 (9%)	
overlayed (3570)		IO1 (1%) .
	SMASH (4%)	I01B (5%)
	1-101	I01D (4%)
		TOLE (4%)

Note: Percentages indicate approximate portions of the total procedure core requirement.

Figure 6-1

7. PROGRAM VARIABLES

At the outset of MAP development a great deal of consideration was given to the program variables. An attempt was made to choose meaningful scalar and array names. Appendix E presents a brief description of all of the program variables.

Most of the program variables are in blank common. The arrangement of common and the structure of the arrays was carefully designed to allow the program size to be modified by redimensioning the arrays.

The following discussion describes the arrangement of variables in common and methods of adjusting array dimensions. In addition, there is a brief description of the few variables whose values are set according to the characteristics of the computer.

7.1 Arrangement of Variables in Common

Table 7-1 illustrates the arrangement of variables in blank common. The variables have been positioned in categories.

The first category contains a group of scalar variables whose values are determined by program array sizes and machine characteristics, and must be initialized individually. These variables are all set to constant values in the subroutine DEPEND. They were placed in a group at the beginning so that the remainder of common could be initialized efficiently.

The intermediate portion of common contains general processing variables. The arrays in this portion will always remain of fixed length.

The last two categories of common variables contain all of the arrays which may be redimensioned to change the program size.

7.2 Adjustment of Array Dimensions

As previously mentioned, the arrays at the end of the common block may be redimensioned. The group of arrays shown as file directory arrays in Table 7-1 store vital information about program I/O. A portion of the arrays is devoted to a directory of the stored masks. Table 7-2 details the information stored in these arrays. All of the arrays have the same dimension, and the scalar DIREND is set (in subroutine DEPEND) to that dimension. This dimension limits the number of masks which can be stored at any time during a MAP run. It should be set at the maximum number of masks to be stored, plus three or four for intermediate scratch mask recordings, plus nine for the non-mask entries. In adjusting the size of the directory arrays, the programmer should keep in mind that available master mask file space must also be considered when determining

BLANK COMMON STRUCTURE

(
CATEGORY	VARIABLES
Version Variables	MACHIN, CHARAC, LARGE, WORDS, ITEMS, LEND, DIREND, SETEND, MU, FACT1, FACT2, FACT3, FACT4
List Pointers	BEG(8), END(8), LOC(9)
Ordered List Pointers	BEGO(3), ENDO(3), LOCO(3), ENTRY(6), START
Flags	OPTN1-OPTN6, MODE1-MODE8, MODE, PAT1-PAT5, SEQ1-SEQ10
Values	VAL1-VAL6, MAX1-MAX6, MIN1-MIN6, SPEC1-SPEC5
File Position Pointers	INP1, INP2, OUT1-OUT5, UNIT
List Segment Flags	FILE(8), STATUS(8), SEG1-SEG5, SEG
Alphanumeric and Command Image	B1, B4, DELIM(36), CARD(76), FIELD(34)
File Directory	NAME(DIREND), NUMI(DIREND), NUM2(DIREND), COUNT(DIREND), RECORD(DIREND)
Lists	SETUP(SETEND), LIST(I)

Table 7-1

DIRECTORY ARRAY'S USAGE

ARRAY	RANGE	USAGE DESCRIPTION
NAME(I)	I=1-4	Equivalent to scalars DESTIN, LAST, MASK, and TYPE.
	I=5-9	Name of last mask output to each logical unit I.
	I=10- DIREND	Name of mask stored in each file position I.
I=1-4 NUM1(I) I=5-9 I=10- DIREND	I=1 -4	Equivalent to scalars CR, IN, LP, and AL.
	I=5-9	Running count of the number of masks output to each logical unit I.
		Highest primary identifier on the mask stored in each file position I.
NUM2(I)	I=1-4	Equivalent to scalars LENGTH, PASS, SKIP, and STAT.
	I=5~9	Data type code of last mask output to each logical unit I.
	I=10- DIREND	Highes: secondary identifier on the mask stored in each file position I.
COUNT(I)	I=1-4	Equivalent to scalars NEXT, TEST, ORD, and OR.
	I=5~9	Running count on number of records out- put to each logical unit I.
	I=10- DIREND	Starting record address of the mask stored in each file position I.
RECORD(I)	I=1-4	Used to store timer data.
	I=5-9	Number records written for the last mask output to each logical unit I.
	I=10- DIREND	Number of records for the mask stored in each file position I.

Table 7-2

the maximum number of masks to be stored during a run.

The arrays shown as lists in Table 7-1 are SETUP(I) and LIST(I). The SETUP array is used to stack processing codes for procedures requiring many steps. It is used to set up the course of action for the TRAC, BOOL, and LIST processes. SETUP(I) must be dimensioned to accommodate one entry for every mask name contained on any TRAC, BOOL, or LIST command record plus ten. The array is also used for other processes and must have a minimum dimension of 20 plus the maximum number of MIN and MAX specifiers used in any SPEC string. The scalar SETEND is set (in subroutine DEPEND) equal to the dimension of SETUP(I).

The array LIST(I) is the core area used to store mask data records during processing. The array may be divided up into "segments" as illustrated in Figure 7-1. The whole segments, first eight divisions, each contain exactly the number of words in a single mask record from the master file. These segments are used as input or output buffers as required by any particular process. They are also used to create ordered lists. The ordering process requires one third more space (i.e., eight words per rectangle instead of six words) during the creation of a list. When the list is sequenced it may then be output through a normal segment. Figure 7-1 illustrates the ordering configurations which may be used, each depending upon the number of segments required for input records.

As shown, the LIST array is divided into 8 2/3 segments plus 12 words for the small buffer at the end. To change the size of LIST(I), the number of rectangles per segment must be determined, multiplied by 6 (words per rectangle) and multiplied by 8 2/3. Twelve plus this value yields the dimension of LIST. There are several scalar values (set in subroutine DEPEND) which are associated with the dimension of LIST. ITEMS is set equal to the number of rectangles per segment (or record). WORDS is set to the number of words per segment (or record) and is simply 6 times ITEMS. Since the segment size must be equal to the size of a file record, the file must be accessed properly. The scalars FACT1-FACT4 are values used in a formula in the function LOCATN to compute a file address for any record.

A general rule for the most efficient dimensioning of these arrays is to first set the directory arrays and the SETUP array sizes as necessary. Then the LIST array should be dimensioned as high as core resources will allow. In general, doubling the size of the LIST array will reduce processing time by one fourth.

When any of these array dimensions are changed, the variable LEND must be reset (in subroutine DEPEND). LEND is a value used to zero part of blank common and is the number of words from BEG(1) through

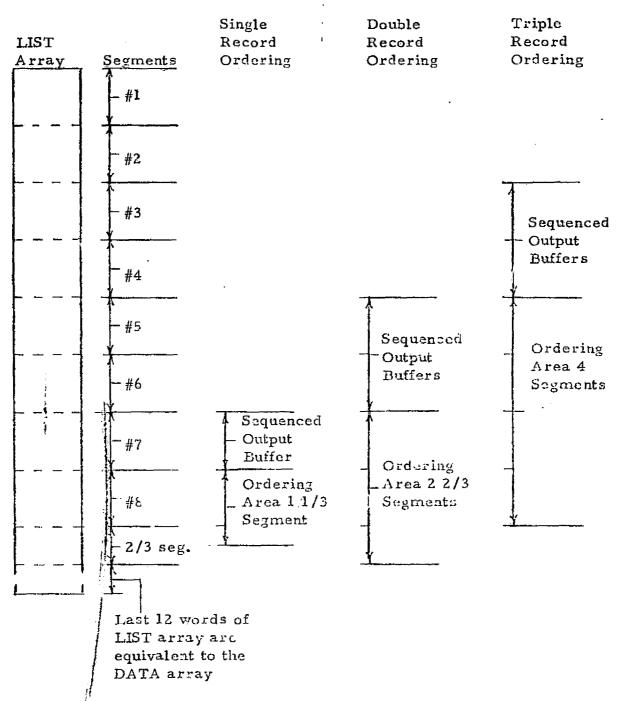


Figure 7-1

the last word in LIST. The following formula may be used to calculate the new value:

LEND = 272 + 5 x DIREND + SETEND + LIST array dimension,

for machines with single word REAL variables, or

LEND = 307 + 6 x DIREND + SETEND + LIST array dimension,

for machines with double word real variables.

7.3 Machine Dependent Variables

As previously mentioned, the first group of scalars in common have values that are determined by program array sizes and machine characteristics. The array size dependent values were discussed in the previous pages.

The machine dependent scalars are MACHIN, CHARAC, LARGE, and are set in subroutine DEPEND. MACHIN is set to the number of bits per word. CHARAC is set to the number of characters contained in a real variable. LARGE is set to the largest possible integer value.

The variables FACTI-FACT4, discussed in regard to the size of the LIST array, are also dependent upon the file addressing scheme of the computer. The variable LEND which is array size dependent also depends upon the word length of real variables as discussed in the previous sections.

APPENDIX A

JOB SETUP EXAMPLES

Table A-1 lists the logical unit assignments for executing MAP. Figures A-1, A-2, and A-3 illustrate the control commands for three typical MAP job setups.

LOGICAL UNIT ASSIGNMENTS

UNIT	DESCRIPTION
1	Command Input Unit (required). OPTN and MASK commands are always read from this unit.
2	Alternate Command Input Unit (optional). See alternate input command option, OPTN command.
3	Command Buffer Unit (required). This must be a sequential disk file.
4	Printed Outpu Unit (optional). See print option, OPTN command.
: 5 - 9	Mask Data Output (optional). See descrip- tions of FILE, TEXT, BOOL, LIST, AREA, PERI, PARE, and RANG commands.
1: 10	Master Mask Unit (required). This must be a keyed or random access disk file depending on the computer.
11-n	Mask Data Input Units (at least one required). See MASK command description.

G

Table A-1

JOB SETUP EXAMPLE 1

1	: 4	·	5	6 T	7 5 9 iC	11 1	2 13	14 15	16 1	7 18	19 20	21	2 2	24	25 2	6 27	28	29 30	31	32 33	34 3	5 3	6 37	ЭВ	39 40	41	42	43 4	4 45	46	47	18 4	9 50	5	52 53	54 5	5 56	57 58	57 60
	ΙĊ	В			1		:	,						-				1	[į			\prod								
	L I	М	I,	r			-	1	i		į		:	i t		! 							İ	and the second			!	,							į į		,		
	A S	s	I	G I	N F:	1	(DΕ	\mathbf{v}_{1}	[C	E .	C	R.)			i i											i												
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This setup includes: all command input from card reader (F:1), printed output (F:4), and data input from a single file (F:11).

Figure A-1

JOB SETUP EXAMPLE 2

1 2 3 4 3	15 7 3 9 10 11 12 13 14 15	14 17 18 19 20 2	1 (2 23 24 25	76 27 28 29 3C	31 32 33 34 3	35 36 37 38 39 40	41 42 43 44 45 46	47 48 49 50 51	57 53 54 55 56	57 58 59 60
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! A SS I	GN F:6,(FI	LE,RES	SULT)	(OUT),(S	AVE)				
IASSI	GN F:10, (F	ILE,M	ASKS)	, (KEY	ED),	OUTIN				
<u> </u>	GN F:12, (F		i i	(IN)						
! RUN	(LMN,MAP)		i	:						
!DATA										
OPTN	(alternate comma	nd input or	otion on)							
			331311 3117				1			
MASK	(unit 12 specified)			1			 	 	 	
! FOD			<u> </u>				 			
! FIN										
					: 11	<u> </u>				1
				1						
			! .	- :						

This setup includes: OPTN and MASK command input from the card reader (F:1), remainder of commands input from a file (F:2), printer output stored on a file (F:4), special output stored on a file (F:6), and data input from a single file (F:12).

Figure A-2

JOB SETUP EXAMPLE 3

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This setup includes all commands input from card reader (F:1), no printer output, and data input from several files (F:11, F:12, F:13).

Figure A-3

APPENDIX B

USER FORMAT DESCRIPTIONS

The following discussion presents the specific details of the I/O formats for this particular version of MAP.

Data format types may be added or replaced in MAP as needed. All versions of MAP, however, must maintain the unique MAP format types -1 and 0.

Table B-1 lists the input and output MAP capabilities which apply to each format type.

Type -1 - MAP Mask File Format

Type -1 format is the format of the master mask file which is created during MAP executions. This is a random access binary file. The record length, the number of records allocated per mask, and the total length of the file are constants defined in the program. MAP will accept this format for input mask data. A file of this format may be externally constructed or saved from some previous MAP run.

Type 0 - MAP List Format

Type 0 format is the other unique MAP format. This format may be elected for FILE or TEXT output and is the standard non-printed output for BOOL, LIST, AREA, PERI, PARE, and RANG. Data is output as sets of records, one set per command. A set consists of:

- o A starting record containing a single value written in IIO format. This value indicates the number of words per record for the remainder of the records in the set.
- o Data records each containing the specified number of words (up to six) of data written in nI10 format.
- o An end record of the same form as a data record except containing all -1 values. This serves as an end of set indicator.

MAP will accept type 0 format for input mask data.

MAP I/O FORMAT SUMMARY

I/O TYPE	INPUT CAPABILITIES	OUTPUT CAPABILITIES
Type -1: Mask File Format	Compatible	Automatically stored during execution.
Type 0: List Format	Compatible	Output via FILE, TEXT, BOOL, LIST, AREA, PERI, PARE, and RANG commands.
Type 1: PRF Format	All elements compatible except text	Output of blocks and text elements via FILE and TEXT commands.
Type 2: MANN Format	Compatible	Output via FILE command.
Type 3; AIDS Format	All elements compatible except text	Output of blocks and text elements via FILE and TEXT commands.
Type 4: Banning Cell Library Source Format	Compatible	Not applicable.

Type 1 - PRF Format

Type I format is the standard PRF format. It is accepted as a mask data input format and it may be used to output data via the FILE or TEXT command.

On input MAP will accept BLOCK, LINE, SHAPE, and COMPONENT data. TEXT data is ignored by MAP, and END COMPONENTS or END LEVEL is interpreted as the end of a mask.

On output, an END COMPONENTS record is written at the beginning of the file. The output for a FILE command is BLOCK data followed by an END LEVEL record. The TEXT command output is TEXT data where the rectangle identifiers are placed in the text string separated by a comma and given the lower left rectangle's coordinate as position points, all followed by an END LEVEL command.

Type 2 - MANN Format

Type 2 format is the standard MANN format. This format is acceptable for mask data input. MAP will accept rotated rectangle definitions and smash them into sets of orthogonal rectangles.

Type 2 format data can be output via the FILE command. The data output is strictly orthogonal rectangles.

Type 3 - AIDS Design File Format

Type 3 format is the standard Sigma 2 AIDS design file format. MAP will accept cell placement, shape, line, and block components as mask input data.

Output via the FILE command causes block elements to be written to a design file. Output via the TEXT command causes individual identifier digits to be stored in the design file as character elements. Type 3 format may be output to any design file for which the display parameter sector has been previously established. If a new file is to be started, the user must select the special new file option on the first FILE or TEXT command in the command set which is associated with the file. This causes a default display parameter sector to be written as the first record of the file.

Type 4 - Banning Cell Library Format

MAP will accept the Banning cell library source format as input. All cell shapes from a single level will be considered a single mask.

There is no provision in MAP for output in type 4 format.

APPENDIX C

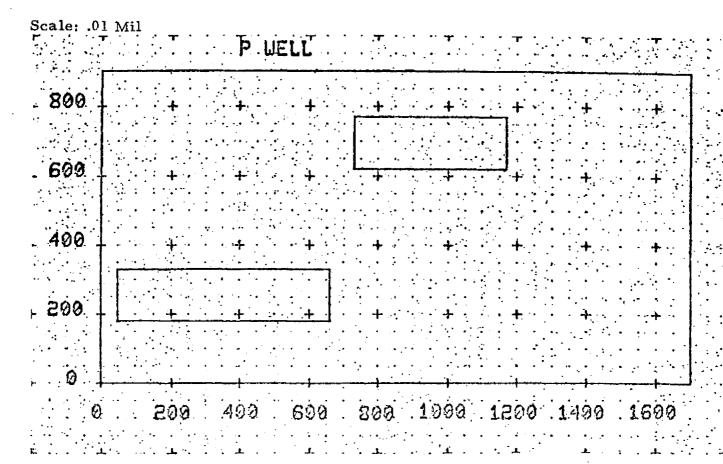
MAP EXECUTION EXAMPLE

This appendix presents an example of a complete CMOS analysis execution. The command set used was specially developed for thorough analysis of CMOS masks. Among the functions performed are: nodal analysis, artwork verification, device identification, capacitance calculation, and equation generation.

The CMOS masks analyzed are very simple and should not be considered to be typical masks. Errors were designed into these masks to illustrate artwork verification capabilities of MAP. Figure C-1 illustrates the form of the original masks as displayed on a CRT. Figure C-2 illustrates the masks after the smashing operation performed by MAP following input of the original masks. Figure C-3 illustrates the N diffusion mask after the negation operation performed early in the run.

The remainder of this appendix contains a portion of the listing produced by the sample execution. The complete command set is presented in the first several pages. Due to the length of the remainder of the complete original listing, only representative portions of the command processing printout were selected for inclusion. The portions contained illustrate each of the analysis functions mentioned above.

ORIGINAL CMOS MASKS



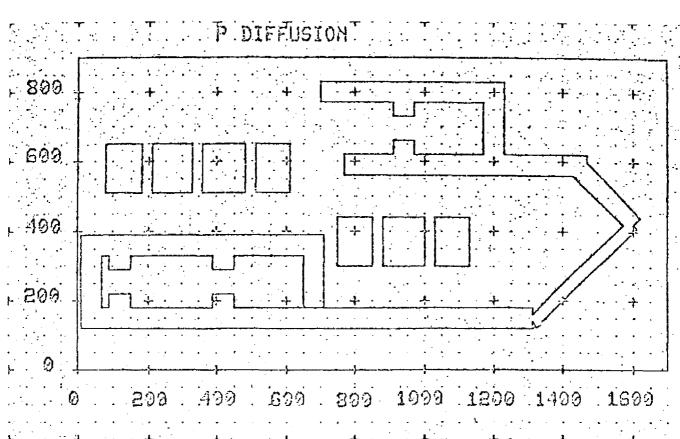
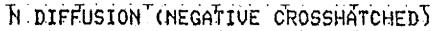
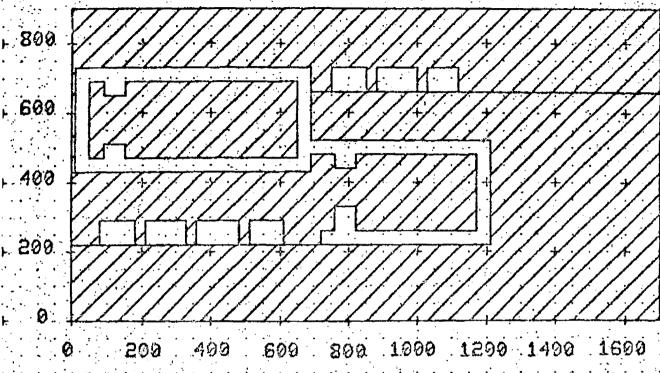
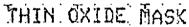


Figure C-1

Scale: .01 Mil







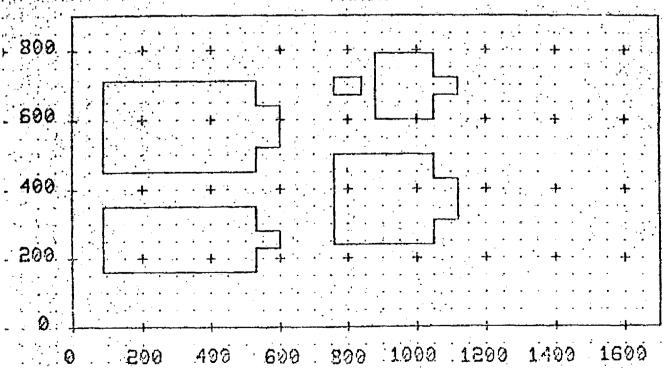
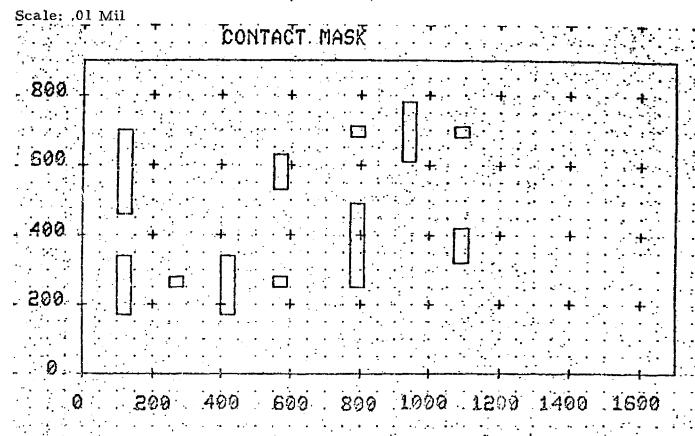


Figure C-1 (continued)

ORIGINAL CMOS MASKS (continued)

E



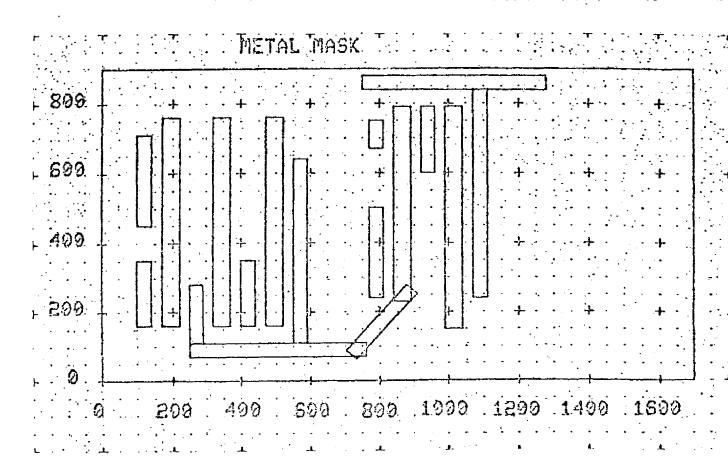
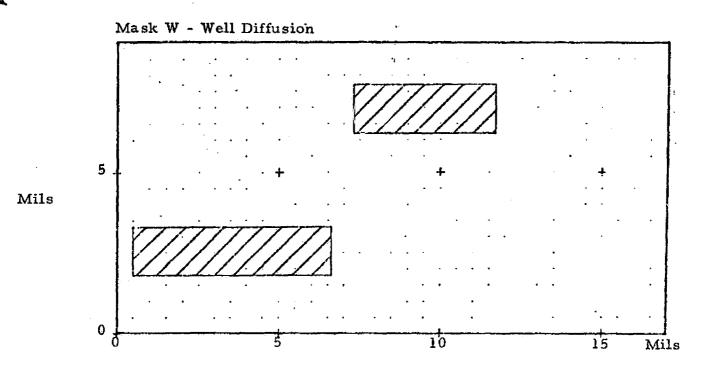


Figure C-1 (continued)

C-4

CMOS MASKS AFTER MAP SMASH



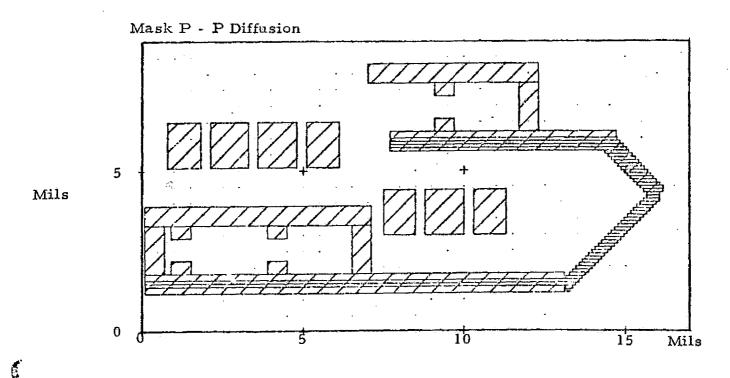
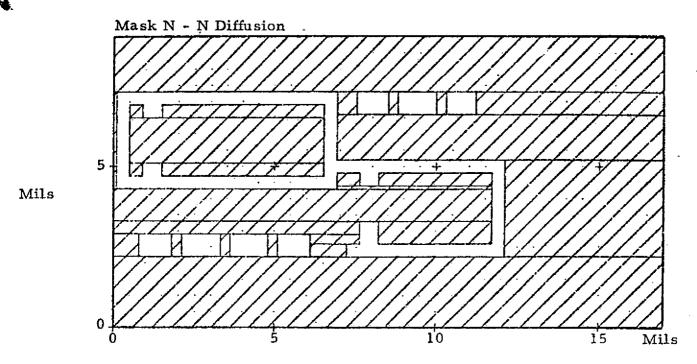


Figure C-2

CMOS MASKS AFTER MAP SMASH (continued)



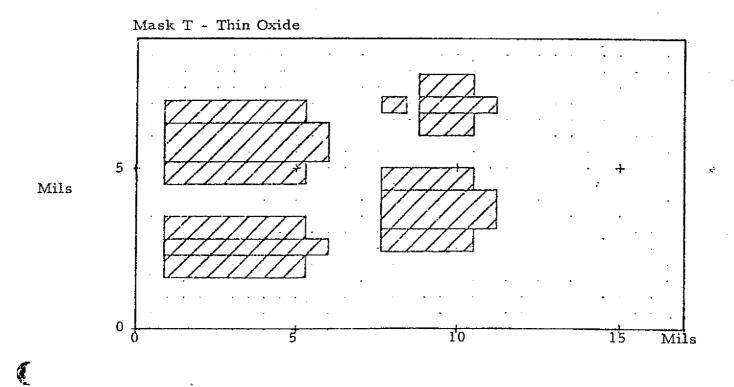
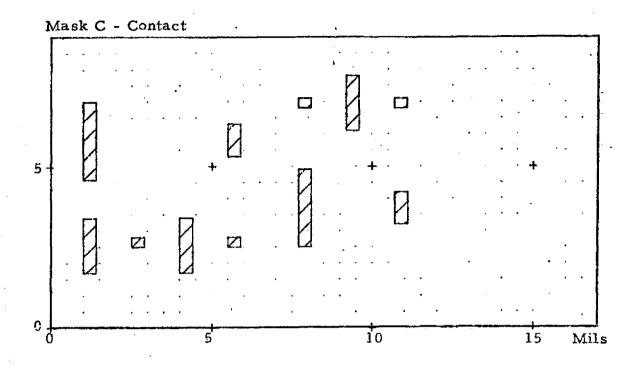


Figure C-2 (continued)

CMOS MASKS AFTER MAP SMASH (continued)



Mils

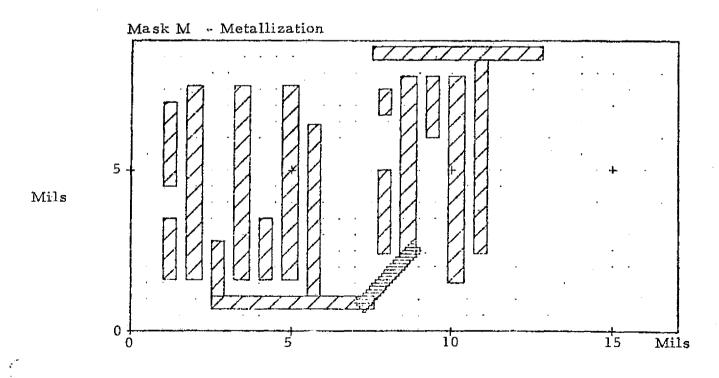


Figure C-2 (continued)

N MASK AFTER NEGATION

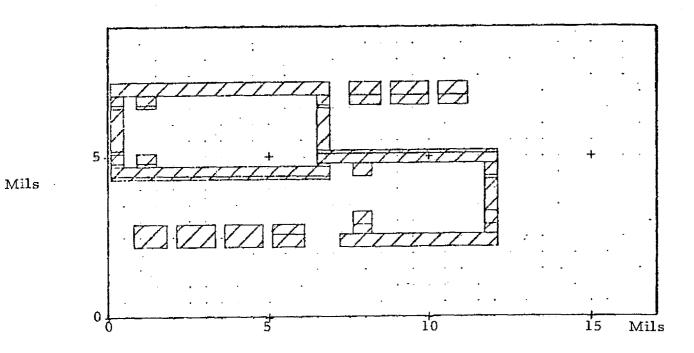


Figure C-3

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MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE.	SCALE = 0.001 MIL	CC000003	<pre></pre>	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W.600 LE 5.1.W XT 5.1.3.W NL P.600	SCALE - 0.001 MIL	CC000002 CC000003 CC000004	<pre></pre>	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W. 600 LE 5.1.W XT 5.1.3.W NL P.600 LE 5.1.P	SCALE - 0.001 MIL	CC000002 CC000003 CC000004 CC000005 CC000006	<pre></pre>	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W.600 LE 5.1.W NT 5.1.3.W NL P.600 LE 5.1.P XT 5.1.3.P	SCALE = 0.001 MIL	CC000002 CC000003 CC000004 CC000005 CC000006 CC000007	<pre></pre>	
MM UNIVERSAL CMBS MASK ANALYSIS PROCEDURE. NL #3600 LE 5313W NL P3600 LE 5313P NL P3600 LE 5313P NL N3600	SCALE - 0.001 MIL	CC000002 CC000003 CC000004 CC000005 CC000006 CC000007	<pre></pre>	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL #3600 LE 5313W NL P3600 LE 5313P NL P3600 LE 5313P NL N3600 LE 5313N		CC000002 CC000003 CC000005 CC000006 CC000007 CC000008	<pre></pre>	
MM UNIVERSAL CM8S MASK ANALYSIS PROCEDURE. NL W: 600 E 5:1:W C 5:1:3:W C 5:1:7 C 5:1:7 C 5:1:3:P C 5:1:3:P C 5:1:3:N C 5:1:3:N		CC000002 CC000003 CC000004 CC000005 CC000006 CC000007	<	
M UNIVERSAL CM8S MASK ANALYSIS PROCEDURE. W.600 E 5.1.W T 5.1.3.W E P.600 E 5.1.P E 5.1.P E 5.1.P E 5.1.A		CC000002 CC000003 CC000005 CC000006 CC000007 CC000008 CC000009 CC000010 CC000011		
M UNIVERSAL CM8S MASK ANALYSIS PROCEDURE. W.600 E 5.1.W T 5.1.3.W NL P.600 E 5.1.P KI 5.1.3.P KI 5.1.3.P KI 5.1.3.N KI 5.1.3.N KI 5.1.3.N KI 5.1.3.N KI 5.1.3.N		CC000002 CC000003 CC000005 CC000006 CC000007 CC000008 CC000009 CC000010 CC000011 CC000012 CC000013	<pre></pre>	
UNIVERSAL CM8S MASK ANALYSIS PROCEDURE. W		CC000002 CC000003 CC000005 CC000006 CC000007 CC000008 CC000009 CC000010 CC000011 CC000012 CC000013 CC000014	<pre></pre>	
MM UNIVERSAL CM8S MASK ANALYSIS PROCEDURE. N. 4000 E 5.1.W KT 5.1.3.W NL P.600 E 5.1.P KT 5.1.3.P KT 5.1.3.P KT 5.1.3.P KT 5.1.3.P KT 5.1.3.P KT 5.1.3.C	REPRODU ORIGINAL	CC000002 CC000003 CC000005 CC000006 CC000007 CC000008 CC000009 CC000010 CC000011 CC000012 CC000013 CC000014 CC000015 CC000016	<pre></pre>	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W.600 E 5.1.W NL P.600 E 5.1.P XT 5.1.3.P NL N.600 LE 5.1.N XT 5.1.3.N NL T.600 LE 5.1.T XT 5.1.3.T YL C.600 LE 5.1.C XT 5.1.3.C	REPRODU ORIGINAL	CC000002 CC000003 CC000005 CC000006 CC000007 CC000008 CC000010 CC000011 CC000012 CC000013 CC000014 CC000015 CC000016 CC000016 CC000017	C	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W: 600 E 5:1:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0 XT 5:1:3:0	REPRODU ORIGINAL	CC000002 CC000003 CC000004 CC000005 CC000006 CC000008 CC000009 CC000010 CC000011 CC000012 CC000013 CC000014 CC000015 CC000015 CC000017 CC000018	Carana	
MM UNIVERSAL CM8S MASK ANALYSIS PROCEDURE. NL M:600 E 5:1:M KT 5:1:3:M KT 5:1:3:M KT 5:1:3:N KT 5:1:3:N KT 5:1:3:N KT 5:1:3:T KT 5:1:3:T KT 5:1:3:C KT 5:1:3:C KT 5:1:3:C	REPRODUCIBII ONGINAL PA	CC000002 CC000003 CC000004 CC000005 CC000006 CC000008 CC000009 CC000010 CC000011 CC000012 CC000013 CC000014 CC000015 CC000016 CC000017 CC000018 CC000019	C	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W.600 E 5.1.W XT 5.1.3.W NL P.600 E 5.1.P NL N.600 LE 5.1.N XT 5.1.3.N NL T.600 LE 5.1.T XT 5.1.3.T VL C.600 LE 5.1.C XT 5.1.3.C LE 5.1.M XT 5.1.3.C XT 5.1.3.M XT 5.1.3.M XT 5.1.3.M XT 5.1.3.C XT 5.1.3.M XT 5.1.3.M XT 5.1.3.M XT 5.1.3.M XT 5.1.3.M XT 5.1.3.M	REPRODUCIBILIT ORIGINAL PAGE	CC000002 CC000003 CC000004 CC000005 CC000006 CC0000008 CC0000009 CC000010 CC000011 CC000012 CC000013 CC000014 CC000015 CC000016 CC000016 CC000017 CC000018 CC000019 CC000019	10 11 12 12 13 14 15 17 18 19 19 19 19 19 19 19	
MM UNIVERSAL CM8S MASK ANALYSIS PROCEDURE. NL W,600 E 5,1,W XT 5,1,3,W NL P,600 E 5,1,P XI 5,1,3,P NL T,600 E 5,1,T XI 5,1,3,T YL C,600 E 5,1,T XI 5,1,3,T YL C,600 E 5,1,T XI 5,1,3,T YL C,600 E 5,1,T XI 5,1,3,T YL C,600 E 5,1,T XI 5,1,3,T YL C,600 E 5,1,T XI 5,1,3,T YL C,600 E 5,1,T XI 5,1,3,T YL C,600 E 5,1,T XI 5,1,3,M MASK E 5,1,M MASK E R,20,S121 M,R220,S224 3,1224 0 ER N = NGIV N	REPRODUCIBILITY ORIGINAL PAGE IS	CC000002 CC000003 CC000004 CC000005 CC000006 CC000008 CC000009 CC000010 CC000011 CC000012 CC000013 CC000014 CC000015 CC000016 CC000017 CC000018 CC000019	C	
MM UNIVERSAL CM8S MASK ANALYSIS PROCEDURE. NL W,600 LE 5,1,W XT 5,1,3,W NL P,600 LE 5,1,7 XT 5,1,3,N NL T,600 LE 5,1,T XT 5,1,3,T VL C,600 LE 5,1,T XT 5,1,3,T VL C,600 LE 5,1,T XT 5,1,3,T VL C,600 LE 5,1,T XT 5,1,3,T VL C,600 LE 5,1,T XT 5,1,3,T VL C,600 LE 5,1,T XT 5,1,3,T VL C,600 LE 5,1,T XT 5,1,3,T VL C,600 LE 5,1,T XT 5,1,3,T VL C,600 LE 5,1,C XT 5,1,3,C VL M,600 LE 5,1,M XT 5,1,3,M YM NEGATION OF THE N MASK LE C,100,S101 M,R200,S20# 3,120# 0 ER N = NGTV N LE 5,1,N	REPRODUCIBILITY ORIGINAL PAGE IS	CC000002 CC000003 CC000004 CC000005 CC000006 CC000007 CC000008 CC000010 CC000011 CC000012 CC000013 CC000014 CC000015 CC000016 CC000017 CC000018 CC000018 CC000019 CC000019 CC000020 CC000020 CC000021 CC000022	C	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W,600 LE 5,1,W XT 5,1,3,W NL P,600 LE 5,1,P XT 5,1,3,N NL T,600 LE 5,1,T XT 5,1,3,N NL T,600 LE 5,1,T XT 5,1,3,C NL G,000 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C NL H,600 LE 5,1,C XT 5,1,3,C XT 5,1,3,C XT 5,1,3,C XT 5,1,3,C	REPRODUCIBILITY ORIGINAL PAGE IS	CC000002 CC000003 CC000004 CC000006 CC000006 CC000008 CC000010 CC000011 CC000012 CC000014 CC000015 CC000016 CC000017 CC000018 CC000018 CC000019 CC000018 CC000019 CC000020 CC000020 CC000023 CC000024	Caracanananananananananananananananananan	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W:600 LE 5:1:W XT 5:1:3:W NL P:600 LE 5:1:P XT 5:1:3:P NL N:600 LE 5:1:N XT 5:1:3:N NL T:600 LE 5:1:T XT 5:1:3:T NL C:600 LE 5:1:T XT 5:1:3:T NL C:600 LE 5:1:T XT 5:1:3:T NL C:600 LE 5:1:T XT 5:1:3:T NL C:600 LE 5:1:T XT 5:1:3:T NL C:600 LE 5:1:T XT 5:1:3:T NL C:600 LE 5:1:N XT 5:1:3:N MM HEGATION OF THE N MASK EC R:0:S:0:1 M:R200:SP0# 3:120# 0 ER N = NGTV N LE 5:1:N MM	REPRODUCIBILITY ORIGINAL PAGE IS	CC000002 CC000003 CC000004 CC000005 CC000006 CC000008 CC000010 CC000011 CC000012 CC000014 CC000015 CC000016 CC000017 CC000018 CC000019 CC000019 CC000020 CC000020 CC000023 CC000024 CC000025	Caracanananananananananananananananananan	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL	REPRODUCIBILIT ORIGINAL PAGE	CC000002 CC000003 CC000004 CC000006 CC000006 CC000008 CC000010 CC000011 CC000012 CC000014 CC000015 CC000016 CC000017 CC000018 CC000019 CC000019 CC000020 CC000020 CC000021 CC000023 CC000024 CC000026	Caracanananananananananananananananananan	
MM UNIVERSAL CMOS MASK ANALYSIS PROCEDURE. NL W:600 LE 5:1:M XT 5:1:3:W NL P:600 LE 5:1:P XT 5:1:3:P NL N:600 LE 5:1:N XT 5:1:3:N NL T:600 LE 5:1:T XT 5:1:3:T NL C:600 LE 5:1:C XT 5:1:3:C NL M:600 LE 5:1:M XT 5:1:3:M MX S:1:3:M MX S:1:3:M MX S:1:3:M MX S:1:3:M MX S:1:3:M MX S:1:3:M MX S:1:3:M MX S:1:3:M MX S:1:3:M MX NEGATION OF THE N MASK EC R:00:S10:1 M:R200:S20# 3:120# 0 ER N = NGTV N LE 5:1:N MX S:1:3:N MX NODAL TRACE / RFCTANGLE : NKAGE MM MM MM MM MM NODAL TRACE / RFCTANGLE : NKAGE	REPRODUCIBILITY ORIGINAL PAGE IS	CC000002 CC000003 CC000004 CC000005 CC000006 CC000008 CC000009 CC000011 CC000012 CC000013 CC000014 CC000015 CC000016 CC000017 CC000018 CC000019 CC000019 CC000020 CC000020 CC000021 CC000022 CC000024 CC000025 CC000026 CC000026	Carana	
NL W,600 LE 5,1,W XT 5,1,3,W NL P,600 LE 5,1,P XT 5,1,3,P NL N,600 LE 5,1,N XT 5,1,3,N NL T,600 LE 5,1,T XT 5,1,3,T NL C,600 LE 5,1,T XT 5,1,3,T NL C,600 LE 5,1,T XT 5,1,3,T NL C,600 LE 5,1,T XT 5,1,3,T NL C,600 LE 5,1,T XT 5,1,3,T NL C,600 LE 5,1,N LE 5,1,M XT 5,1,3,M MM HEGATION OF THE N MASK EC R100,S101 M,R200,S20# 3,120# 0 ER N = NGTV N LE 5,1,N XT 5,1,3,N MM	REPRODUCIBILITY ORIGINAL PAGE IS	CC000002 CC000003 CC000004 CC000006 CC000006 CC000008 CC000010 CC000011 CC000012 CC000014 CC000015 CC000016 CC000017 CC000018 CC000019 CC000019 CC000020 CC000020 CC000021 CC000023 CC000024 CC000026	Caracanananananananananananananananananan	

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		'		
	FILE	5,1,2	CC000031	<
	TEXT	5,1,3,P	CC00003S	< 32
	FILE	5.1.N	CC000033	<pre><pre><pre><pre><pre><pre><pre>33</pre></pre></pre></pre></pre></pre></pre>
	TEXT	5,1,3,N	CC000034	<
	FILE	SalaC	CC000035	<
	TFXT	5,1,3,0	CC000036	<36
	FILE	5.1.M	CE000037	< 37
	TEXT	5,1,3,M	CC000038	< 38
	COMM	LINKAGE OF CONNECTED WELL RECTANGLES AND RENUMBERING		
			CC000039	<u> </u>
	SPEC	R181,S101 N	CCDD0040	<
	APER	W = LINK W LINE	CC000041	<
	FILE	5,1,h	CC000042	<42
	TEXT	5,1,3,4	CC000043	<
	CSMM	LINKAGE OF CONNECTED THIN OXIDE RECTANGLES AND RENUMBERING	CC000044	<
	SPEC	R181.8101 W	CC000045	<
	BPER	T = LINK T LINE	CC000046	
	FILE	5,1,7	CC000047	< <u>4</u> 7
-	TFXT	5,1,3,1	CC000048	<
	COMM	dr 4 # dr 1	CC080049	
	CSYM	GENERAL ARTWORK CHECKING - PHASE 1		49
		BE SEAME WELLOWK CHECKING - LUNSE I	CC000050	< 50
	CBMM		CC000051	<
•	COMM		CC000052	< 52
	Camm	ERROR: MINIMUM N-P SPACING BETWEEN DIFFERENT NODES . 0.4	CC000653	< 53 <u></u>
		ĦĨĹ	CC000054	< 54 ·
	SPEC	PRNT:MAXW=399	CC000055	< 55
	SPER	NPSF = THIX NAP DIFF	CC000056	< 56
_	FILE	5.1.NPSE	CC000057	<u> </u>
Ç)	TEXT	5,1,3,NPSE	CC000058	
⊺	FREE	NPSF	CC000059	
-	าั <u>ด</u> ธิหัก"	ERROR: MINIMUM METAL LINE WIDTH = 0.4 MIL		59
_			CC000060	< 60
	SPEC	MAXX=399	CC000061	
	SPER	MLWX = SAME M	CC000065 ,	< 6 <u>2</u>
	SPEC	MAXY*399	CC000063	<
	ባታደጓ '	MLWY = SAME M	CC000064	<
	SPEC	PRNT	CC000065	< 65
	Teren"	MLAF - PLUS MLAXAMENY	CC000066	<
	FREE	MENXAMENY	CC000067	< 67
	FILE	5,1, MinE	CC000068	<
	TEXY	5,1,3,MLWE	CC000069	
-	FREE	BLAF 9		69
			CC000070	< 70
	COMM	ERROR: MINIMUM METAL-METAL SPACING = 0.3 MIL FOR LINES	CC000071	<u> </u>
	тсэнчт	< 10 MILS Lang	CC000072	< 72
	SPEC	PRNT MAX # 299	CC000073	< 73
	BPER	MMSE = TWIX M DIFF	CC000074	< 74
	FILE	5.1.MMSE	CC000075	<
	TEXT	5,1,3,MMSE	CC000076	< 76
	Cana	FREER: MINIMUM METAL-METAL SPACING = 0.4 MIL FOR LINES	CC000077	< 77
	Carm	> 10 MILS LANG	CC000077	
		PRNT/MINL*10001/MAXW*399		<
			CC000079	<
		MMSE * TWIX M DIFF	CC000080	<
		5,1,MMSE	CC000081	<
	TEXT		CC000032	< 82
	FREE		CC000083	< 83
	Сэми	ERROR: MINIMUM METAL/THIN OXIDE SPACING = 0.2 MIL	CC000084	< 84
	SPEC	PRNT, MAXW=199	CC000085	< 85

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<u>BPER</u> .	MTSE * TWIX MJT	CC000086		86	
FILE	5,1,MTSE 5,1,2,MTSE	CC000087	<	87	
FREE	5,1,3,MTSE MTSE			. 88	
COMM	MI OF	CC000089	<	89	
CBMM	SEPARATION OF P DIFFUSION INTO ACTIVE OR GUARD BAND AREAS	CC00C090		<u>00</u>	
BPER	PA = NLNX P.W LINE LINE	CC000091	<	91	
FILE	5/1/PA	55000032		92	
TEXT	5,1,3,PA	CC000093	<	93	
BPER	PG = NINT P.PA	CC000094		94	
	5,1,PG	CC000095 CC000096	<pre></pre>	95 2	
TEXT	5,1,3,PG	CC000098		96	
COMM	SEPARATION OF N DIFFUSION INTO ACTIVE OR GUARD BAND AREAS	CC000098	<	97	
BPER	NA . INTR N.W	CC000099		98	
FILE	5.1.NA	CC000100		99	
TEXT	5.1.3.NA	CC000101		- 100. 101	
9.PER_	NG - NINT NANA	CC000101	C====================================	102	
IFNL	35/10	CC000103		103	
FILE	5,1,NG	CC000104	<	104	
TEXT	5,1,3,NG	CC000105	<pre></pre>	105	
COMM		CC000106.	<	106	
семи	ERROR: MINIMUM N GUARD BAND WIDTH * 0.4 MIL	CC000107	<	107	
8250	PRNT_MAXA#399	CC000108	<	108	
SPER	NGWE - SAME NG	CC000109	<	109 ·	
FILE	5.1.NGME	CC000110	<	110	
CATERT	5,1,3,NGHE :	CC000111	<	111	
FREE	NGNE	CC000112	<	112	
IFNL	PG.25	CC000113	<	113	
COMM.	FREER: MINIMUM P GUARD BAND WIDTH BUTSIDE OF WELL . 0.6 MIL	CC000114	<	114	
SPEC	PRNTAMAXA = 599	CC000115	<	115	
BPER	PGAE = NINT PG/W	CC000116		116	
FILE	5,1,PG+E	CC000117 ·	<	117	
TEXT	5,1,3,PGWE	CC000118		118	
FREE	FORE STILL BEDIEFER MINE MEET ON AVENUAGE DOWN-	CC000119	<	119	
COMM	FREST: WELL PERIMETER MUST MEET OR OVERLAP P GUARD BAND WPER * EDGE W SAM!	CC000120		120	
-		CC000121	<	121	
9PER 5PEC	WPER = EXPN WPER 5,5 PRNI,MINA=10	CC000155		155	. <u>. </u>
SPER	COSO - ATAIT LOSS AND	CC000123	<	123	
FILE	Estawper	CC000124		124	
TFXT	5,1,3,4PER	LC000125	<	125	
-FREE-	WPER	CC000126		126	
IFNL	NG/10	CC000127	<	127	
COMM	ERROR: N GUARD BAND MAY NOT INTERSECT P GUARD BAND, MAY	CC000128		128	·
CoMM	INDICATE AN ERROR IN THE SEPARATION OF N ACTIVE	CC000125 CC000130	<	129	
- CSMM	AND N GUARD BAND AREAS DUE TO IMPROPER EMBEDDING	CC000131		130	
CBMM	OF N ACTIVE WITHIN THE WELL	CC000131	<pre><pre></pre></pre>	131	
SFEC		CC000132		13<	
	NWEE = INTR NG.PG	CC000133		133	
FILE		CC000135		134	
YEXT		CC000136		135	
FREF	NWEE	CC000135		136	
TENL	PA#118	CC000137		137	•
Сени	ERROR: N GUARD BAND MUST TOTALLY SURROUND ALL P ACTIVE	CC000133	<pre><pre></pre></pre>	_138	
COMM	AREAS	CC000140	<	139	
				140	`

∂PER	VNG - VTWX NG SAME	CC000141	<	141	
DPER	VNG . LINK VNG.PA LINE LINE	CC000142		142	
BPER	HNG # HTHX NG SAME	CC000142 CC000143	<	143	
ePUR	HNG . LINK HNG/PA LINE/LINE	CC000144			
SPEC	PRNY		4-44-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4-4	144	
BPER	SURE * EXBR HNG, VNG	CC000145		_145	
		CC000146	<pre><</pre>	146	
FILE	5,1, SURE	CC00C147		147	
TFXT	5,1,3,SURE	CC000148	<	148	
FREE	VNS, HNG, SURE	CC000149		149	
CBMM		CC000150	<	150	
CBMM	P TRANSISTER IDENTIFICATION / CHECKING	CC000151	<	151	
CaMM		CC000152	<	152	
CBMM		CC000153	<	153	
CSWW	LOCATION OF PROSPECTIVE P CHANNELS, ARBITRARILY ASSUMING	CC030154	<	154	
COMM	THAT ANY CHANNEL UP TO 1 MIL LONG WITH AT LEAST 0.1 MIL	CC000155	<	155	
CBMM	METAL AND THIN BXIDE WILL PERFORM SOMEWHAT LIKE A TRANSISTOR	CC000156		156	
SPEC	MAXW=1000,R150,S1g# 1,R200,S2g# 1	CC000157	<	157	
6258	PPC . TWIX PA DIFF	CC000158	<	158	
TENL	PPC.97	CC000159	<	159	
SPEC	MINA#100	CC000160		160	
SPER	PC = INTR PPC = T	CC000161	<	161	
SPEC	MINA=100	CC000142		162	
9758	PC = INTR PC.M	CC000163	<	163	
- Faca-	GPC W LINK PPC.PC NBNEJAREA	CC000164		164	
SPEC	R131,513# 1	CC000165	(165	
O PER	OPC . LINK GPC LINE	CC000165		166	
FILE	5,1,9PC	CCC55167	4	_	
·	5,1,3,GPC	CC000168		167	-
FREE	PPC.PC	CC000169	(168	
CSMM	77 631 6			169	
CSMM	ERROR: MINIMUM 2 CHANNEL LENGTH . 0.3 MIL. WIOTH . 0.7 MIL	CC000170		170	
SPEC	MAXW=299.MAXL=699	CC000171		171	
		CC000172	<	172	
BPER		CC000173		173	
TENL	PCE,5	CC000174	<	174	•
SPEC	PRNT	CC000175		175	
BPER	PCE TEINK PCETOPC NONETAKEA	CC000176	<	176	
FILE	5,1,PCE	CC000177		177	
TEXT	5,1,3,PCE	CC000178	<	178	28
CBMM	ERROR: MINIMUM THIN OXIDE WIDTH OUTSIDE EDGES OF P	CC000179	<	179	
Cemm	CHANNELS # 0+2 MIL	CC000180	<	180	₽ =
APER	PCE • EXPN GPC 200,200	CC0aciai	<	181	見る
FAL	PCE.5	CC000132		182	<u> </u>
SPEC	PRNT	CC000183	<	183	REPRODUCINILII ORIGINAL PAGE
PPER	PCE - NINT PCE.T	CC000184		184	
FILE	5.1.PCE	CC000185	<	185	<u> </u>
TFXI	5,1,3,PCE	CC000186		186	—— —————
СВИМ	ERROR: MINIMUM METAL WIDTH BUTSIDE EDGES OF P CHANNELS	CC000187	<pre></pre>	187	H H
Санн	# U.I. MIL	CC000188			
SPER		CC000189	*****	188	
TENL	PCE.5			189	
	PRNT	CC000190	C	190	<u> </u>
SPEC	PCE - NINT PCE/M	CC000191		. 191	
		CC000192		192	. 7 33
	5,1,PCE	CC000193	<	193	
	5.1.3.PCE	CC000194	<	194	
FREE	PUE	CC000195		195	

CBMM		CC000196	<	196	
CSMM	LOCATION OF P SOURCES AND DRAINS	CC000197		197	
SPEC	R120,310# 1	CC000198	<	198	
SPER	PSD - SAME PA	CC000199	<pre></pre>	199	
SPER	PSD = LINK PSD: OPC LINE: LINE	CC000200	C	200	
PPER	PSD . INTR PSD.PA	CC000201	<	201	
FILE	5.1.PSD	S0S00000	<	202	
TEXT	5,1,3,750	CC000203	<	203	
CBMM		CC000204	<	204	
Camm	ERROR: P SOURCE AND DRAIN MINIMUM WIDTH # 0.1 MIL	CC000205	<	205	
SPEC_	FRNT, MAXA=99	CC000506	<	206	
525R	PSDE = SAME PSD	CC000207	<	207	
FILE	5,1,PSDE	8020000	<	208	
TEXT	5,1,3,PSDE	CC000509	<	209	
Camm	ERROR: MINIMUM SEPARATION OF THIN DXIDE TO BUTSIDE P	CC000210		210	
CBMM	SOURCE AND DRAIN EDGES = 0.1 MIL	CC000211	<	211	
<u> PPER</u>	PSDE EXPN PSD 5.5	CC000S1S		515	
1FAL	PSDF.5	CC00C213	<	213	
SPEC	PRNTAMAXA#104	CC000214		214	
FPER	PSDE = NINT PSDE/T	CC000215	<	215	
FILE	5,1,PSDE	CC000216		216	
TEXT	5,1,3,PSDF	CC000217	<	217	
<u></u>	PSDE	CC000218		218	
Сэхн	and the of a subsection of the	CC000219	<	219	
CSYM	LECATION OF P CHANNEL GATE METAL	0SS00020		550	
~ 52EC	Rizo, Sida 1	CC000551	<	221	
O spari	PGM + SAME M	CC000555		555	
- PER	PGM = LINK PGM/QPC LINE/AREA PGM = INTR PGM/M	CC000553	<	553	
ლ შ₽ER FILE	5,1,P3M	CC000224			
TEXT	5,1,3,PGM	CC000225	<u> </u>	225	
CSAM	371737760	65000226		556	
CEYM	ERROR: MINIMUM P CHANNEL GATE METAL WIDTH # 0.5 MIL. A	CC000227	<	227	
Carm	REDUNDANT TEST SINCE CHANNEL WIDTH AND METAL WIDTH	CC000228		558	
Carm	BUTSIDE CHANNEL HAVE BEEN CHECKED	CC000555	<	229	
- E5E8	PGMF * EXPN GPC 200, 200	CC000530		_530	
TENL	PGMF,5	CC006231	C	231	
SPEC	PENT MAXA = 499	CC000535		535	
97ER	PGME = INTR PGM.PGMF	CC000233 CC000234	<	233	•
FILE	5,1,PGME	CC000235		234	
TEXT		CC000236	<	235	
- cePH	ERROR: MINIMUM P CHANNEL GATE METAL OVERLAP ON N GUARD	CC000237		236	
RMBS	BAND * 0.5 MIL	CC000237	<	237	
5055	PGME - EXPN NG 50,50	CC000239	**************************************	238	
1FNL	PGPF,5	CC000239		239	
SPEC	PRNT, MAXA = 249	CC000240		240	
9958	PSMF = INTR PSM/PSMF	CC000242		241	
	5/1/PG*E	CC000242		_ 242 	
TFX	5,1,3,P3ME	CC000244	<pre></pre>	244	
сайм	ERROR: P CHANNEL GATE METAL MIGT CROSS THE N GUARD BAND	CC000245		245	
Canh	INSIDE EDGE BEFORE CHOESING THE THICK BXIDE STEP	CC000246	<	246	
SPER	POME . LINK TING LINE LINE	CC000247	<	247	 .
8258	POME . THIX NG. POME	CC000248	<	248	
SPEC	PRNT	CC000249	<	249	
	PGME = INTR PGNJPGMF	2000250	= - - -	~ T ~	

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FNE	5,1,PGME	CC000251	<
TEXT	5.1.3.PGME	CC000252	< 252 Z
FREE	PGME	CC000253	< 253
COMM	at 100 th and the second of th	CC000254	< 254
CBMM	N TRANSISTOR IDENTIFICATION / CHECKING	CC000255	< 255
CeMM		CC000256	<
CBMH		CC000257	< 25.7
1FNL	NA/104	CC000258	< 258
Cakk	LOCATION OF PROSPECTIVE N CHANNELS, ARBITRARILY ASSUMING	CC000259	<
CBMM	THAT ANY CHANNEL UP TO T MILL LONG WITH AT LEAST 0.1 MIL	CC000260	<
семм	METAL AND THIN GXIDE WILL PERFORM SOMEWHAT LIKE A TRANSISTOR	CC000261	< Z51
SPECT		CC000565	< 262
. APER	PNC = TWIX NA DIFF	CC000263	<u> </u>
TFNL	PNC, 97	CC000264	< 264
SPEC	MINA=100	CC000265	<u> </u>
4554	NC * INTR PNC.T	69200035	< 266
SPEC	M!NA=100	CC000267	<
FER	NC a INTRINCIR	865cog20	< 26 8
a peq	GNC = LINK PNC, NC NONE, AREA	CC000269	< 269
SP59	Rigi, Sigi GPC	CC000270	< 270
EPER	ENC = LINK ENC LINE	CC000271	< 271
FILE	5,1,0\0	CC000272	< 272
TEXT	5/1/3/200	CC000273	<u> </u>
	PNCINC	CC000E74	< 27 ⁴ .
germ		CC000275	<
~ Fask	ERROR: MINIMUM N CHANNEL LENGTH * 0.3 MIL. WINTH - 0.7 MIL	CC000276	< 276
O PEC	MAX=299.MAXL=699	CC000277	
i arth	NCE = THIX NA DIFF	CC000278	< 278
JANE 4	NCE.5	CC000279	< 279
TT'SPEC	PR': 1	CC000880	< Z80
FRER	NCE = LINK NCE-ONC NONE-AREA	CC000281	281
FILE	5,1,\CE	CC000585	< 282
TEXT	5.1.3.NCE	CC000283	<u> </u>
Cann	ERROR: MINIMUM THIN BXIDE WICTH BUTSIDE EDGES OF N	CC000284	< 28 ⁴
CHMM	CHANNELS + Q+2 MIL	CC000285	<
each.	MCE & EXPN GNC 200,200	CC000588	< 2E6
†FNL	NCE/5	CC000287	<u> </u>
SPEC	PRNT	CCoppeas	<======================================
8258	NCE * NINT NCE/T	6850002D	< 289
FILE	5,1,NCE	CC000530	< 290
TEXT	5,1,3,NCE	CC000291	<u> </u>
	ERROR! MINIMUM METAL WIDTH BUTSIDE EDGES OF N CHANNELS	CC000535	< 292
Cedin	e O.1 MIL	ccooosaa	<u> </u>
TT SPER	NCE = EXPN GNC 100,100	CC000294	< 294
[FNL	NCE.5	CC000295 <u></u>	<
5.2E.C	PRNT	CC000296	<pre><pre><pre><pre><pre><pre>296</pre></pre></pre></pre></pre></pre>
eper	NCE * NINT NCE/M	CC000297	<u> </u>
FILE		CC000298	< 298
TEXT	5,1,3,NCE	CC000299	
FREE	NCE	CC000300	< 300
CSHM		CC000301	<u> </u>
CEMM	LOCATION OF N SOURCES AND DRAINS	CC000305	<
SPEC	Risc, Slav 1	CC000303	< 303
APER	NSD . SAME NA	CC000304	<
<u>eper</u>	PSD = LINK NSD, GNC LINE/LINE	CC000305	<u> </u>

		······································		
8000	NOT THEN NOT MA	85n004 :		D- 4
BPER FILE	NSD = INTR NSD,NA 5,1,NSD			356
TEXT		CC000307	<	307
CAMM	5,1,3,NSD	CC000309		308
CSMM	ERROR! N SOURCE AND DRAIN MINIMUM WIDTH = 0.1 MIL		<	309
SPEC	PRNT MAXA = 99	CC000310		310 311
OPER	LONG MANE NAB		<pre><pre></pre></pre>	312
FILE	SILINSDE	CC000313		313
TEXT	5.1.3.NS0F	CC000314	/	314
CEPH	ERROR: MINIMUM SEPARATION OF THIN EXIDE TO OUTSIDE N	CC000315		315
COMM	SOURCE AND DRAIN FDGES # 0.1 MIL	CC000316	<	316
	ASOF = EXPN ASD 5.5	CC000317	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	317
IFNL	NSOF, 5	550-0040	<	318
SPEC	PRNTAMAXA=104	CC000319	C+++++++++++++++++++++++++++++++++++++	319
SPER	NSDE - NINT NSDE T	000-0000		320
FILE	5,1,NSDE	CC000321		321
TEXT	5,1,3,NSDE	CC000355	<	322
FREE		ESECCOSS	C	323
COMM		CC000324	<	324
Camm	LECATION OF N CHANNEL GATE METAL	CCDOD325	<	325
SPEC	R190, S10 = 1	6SE00032		326
SPER	NGM = SAME M	CC000327	<	327
eper	NGM - LINK NGM, ONC LINE LINE	CC000328	<	328
PER	NGM * INTR NGMJ M	CC000329	<	389
FILE	5,1,NGM	0000330		330
TEXT	5,1,3,NGM	CC000331	<	331
C CBHM	·	ccooo332	<	332
I COMM	ERROR: MINIMUM N CHANNEL SATE METAL WIDTH . 0.5 MIL. A	CC000333	<	333
L COMM	REDUNDANT TEST SINCE CHANNEL WIDTH AND METAL WIDTH	CC000334	<	334
Eaww_	BUTSIDE CHANNEL HAVE BEEN CHECKED	CC000335	<	335
4564	NGME = EXPN GNC 200,200	CC000336		336
IFNL	NGMF,5	CC000337	<	337
SPEC	PRNTJ MAXA * 499	&CC000338 <u></u>		338
SPER	NGME = INTR NGM/NGMF	CC000339	<	339
FILE_		CE000340	<	340
TFXT	5, 1, 3, NGME	CC000341	<	341
COMM	ERPOR: MINIMUM N CHANNEL SATE METAL OVERLAP ON P GUARD	CC000342		342
COMM	- BAND = 0.2 MIL	CC000343	<	343
SPER	NGMF = EXPN PG 50.50	44E00032		344
FNL	NGME, 5	CC000345	<	345
	PRNT / MAXA + 249	CC000346		346
- PEA	NGME * INTA NGMINGHE	C5000347	<	347
FILE	5.1.NGME	CC000348		348
TEXT	5,1,3,NGME	CC000349	<	349
CBMH	ERROR: N CHANNEL GATE METAL MUST CROSS THE P GUARD BAND	CC000350		350
Camm	INSIDE EDGE BEFORE CROSSING THE THICK OXIDE STEP	CC000351	<pre><pre></pre></pre>	351
	NGME - LINK TIPG LINE LINE	CC000352		352
	NGME # THIX NGINGME	CC000353	<	353
SPEC	PRNT	CC000354		354
-PER	NGME - INTR NGMANGME	C <u>C</u> 00035 5	<	355
FILE	5)1,NGME	CC000356		. 356
TEXT	5,1,3,NGME '	CC000357	<	357
FREE	NGME	CC000358	<u> </u>	358
carn		CC000359	<pre><pre><pre></pre></pre></pre>	359
ceam_	GENERAL ARTWORK CHECKING - PHASE 2	CC00036 0		360

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сами		CC000361	<	361
MMED		CC000362		362
CBMM	ERROR: MINIMUM SPACING DETWEEN A NON SOURCE OR DRAIN	CC000363	<	363
Carm	DIFFUSION AND ANY OTHER P DIFFUSION WITH A	CC000364		364
CaMM	DIFFERENT NODE NUMBER = 0.4 MIL	CC000365	<	365
APER		CC000366		366
IFNL	PNSD.8	CC000367	<	367
FILE		CC000368		368
TFXT		CC000369	<	369
SPEC		CC000370		370
SPER	· · · · · · · · · · · · · · · · · · ·	CC000370		
FILE				371
TEXT		CC000372	************************************	372
TREE		CC000373		373
Cakk		CC000374	<	374
COMM		CC000375		375
CBMM	DIFFUSION AND ANY OTHER N DIFFUSION WITH A	CC000376	<	376
Cary		CConc377		377
EPER	NISD = NINT NIASD	CC000378	C	378
		CC000379		379
TENL	NNSD:8	CC000330	<	380
FILE		ccooo331	<u> </u>	381
TEXT	5,1,3,8%50	CC000382	<	382
SPEC		E8E0C022	<	383
3254	•	CC000384	(384
FILE		CC000385		385
TEXT	5,1,3,NNSE	CC000386	<	386
O FREE		CC006387		387
L Cark		CC000388	<	388
		CC000389	<	389
	I.E., ANY ITEM WITH A DIMENSION < 0.3 MIL OR ANY	CC000390	<	390
COMM		CC000391	<	391
COMM	AND 0.4 MIL ARE IN ERROR	CC000335 .	<	392
SPEC		CC000393	<	393
TOPER	CS * SAME C	CC000394	<	394
SPEC		CC000395	<	395
BPER	CSE T NINT C.CS	CC000396		396
F!LE	5,1,CSE	CC000397	<	397
TEXT	5,1,3,CSE	CC000398		398
SPEC	PRNT_MAXA=399	CC000399	<	399
. DEER	CSE - SAME CS	CC000400		450
FILE		CC00C401	£	401
TFXT	5,1,3,CSE	CC000402		432
FREE	CS, CSE	CC000403	<	403
COMM	ERROR: MINIPUM SEPARATION OF STEPPED OPENING AND ANY	CC000404		404
CSHH	CONTACT OPENING = 0.1 MIL	CC050405	<	455
BPER.	EXC * EXPN C 100,100	CC000406		406
SPEC		CC000407	<	407
	CTOF * VINT EXCAT	CC000408		408
	5,1,CT9S	CC000409	<u> </u>	409
TEXT		CC000410		
FREE	- · · - · · -	CC000410		410
—-ceha		CC000411		- 411
Camm	BE SOURCE OR DRAIN DIFFUSIONS . O.S MIL	CC000412		412
	SD = PLUS PS07NSD	CC000413		413
SPEC				414
	- Proving Project (大学 Andrews Communication of the Communication of th	CC000415		415

2050	CDCC - NINT CD.C	CCoopeli	
#PER	SDCE * NINT SD.C 5.1.SDCE		<u> </u>
FILE		CC000417	<
TFXT	5,1,3,SPCE		<
FREE	SDCE	CC000419	112
<u></u>	ERROR: METAL MUST COMPLETELY COVER SOURCE AND DRAIN CONTACT OPENINGS	CC000420	<u> </u>
CaMM		CC000421	<
PER			422
SPEC	PRNT	CC000423	· <
SPER	MCGF = NINT SDC.M	CC000424	<u> </u>
FILE	5.1.MCBE	CC000425	<
TFXT	5/1/3/MC9E	CC000486	<u> </u>
CBMM	ERROR: MINIMUM METAL OVERLAP OVER EDGE OF OTHER CONTACT	CC000427	< 427
COMM	8PENINGS * 0.2 MIL	CC000428	<
PPER	BC = NINT C.SDC	CC000429	<
1 FILL	CC/6.	CE000430	<u> </u>
유로틴	EXEC * EXPN 8C 200,200	CC000431	<
SPEC_	PRNT	CC000432	<u> </u>
SPER	MCOF = NINT EXOCAM	CC000433	< 433
FILE	5,1,MC9E	CC000434 <u></u>	<u> </u>
TFXT	5,1,3,MC8E	CC000435	<
FREE	SDC, BC, EXBC, PNSD, NNSD, MCBF	6E400030	436
CBMM	ERROR: MINIMUM PENETRATION OF THIN OXIDE WITHIN GUARD	CC000437	<
COMM	BAND FOR GATE METAL CROSSOVER . 0.2 MIL	CC000438	<
SPER	GM • PLUS PGM, NGM	CC000439	< 439
5253	GB = PLUS PG.NG		< 440
APFR	TOXF = INTR GM, GB	CC0C0441	<
O_{1}	TOXF.5		<
- 5PEC	PRNT, MAXA*199	CC00C443	< 443
7.49ER	TOUR - THERE T. TOUR	CCCCCAAA	< 444
	5,1,TOXE	CC000445	<
TEXT	5.1.3.T8XE	CC000446	<
Fafe	SM>GB	CC000447	C
CSMM	GODANA MINISHIM CAMPDISTAN BESTERN THIS OFFICE INS. 117	#C	< 448
CBMM	SUTSIDE SOURCE OR ORAIN # 0.2 MIL	CC000449	C
SPEC	PRNTAMAXW×199	CC000450	4.50
SPER	TEXE = THIX T.SD	CC003451	the state of the s
	541. Texe	CC000452	42.
FILE	5,1,3,70xE	CC000452	<u> </u>
TEXT			<
FREE	SD ERROR: MINIMUM SEPARATION OF THIN UXIDE AND ANY OUTSIDE	CC000454 CC000455	
CSYM	METAL # 0.2 MIL	CC000456	455
CBHM_	FRNT,M4Xm *199		<u> </u>
SPEC		CC000457	<
5PER	TOXE = Talx Tam	CC000458	<u> </u>
FILE	5,1,T0XE	CC000459	<
	5)1,3,70XE	CC000460	450
	TOXE	CC000461	< 461
ceyM_		CC000462	462
Cahh	CAPACITANCE CALCULATION	CC000463	<
Cerm	· · · · · · · · · · · · · · · · · · ·	CC000464	<u> </u>
CBMM		CC000465	<
CaMM	EXPAND DIFFUSIONS TO COMPENSA" FOR UNDERCUT . 0.05 MILS	CC000466	<===============================
PER	EXP # EXPN P 50.50	CC000467	< 467
PER	EXN . EXPN N 50.50	CC000468	<468
C6YM	CATEGORIZE THE METAL ACCORDING TO THICKNESS OF EXIDE	CC000+69	<
	BENEATH IT.	CC000470	<u> </u>
AND SHORT OF SHIP SHIP	the state of the s		

The Control of the Co

PER	MTHN = INTR M.T	CC000471	<	471
PER:	MTHK * NINT MAMTHN	CC000472	<	472
MM	SUBTRACT CONTACT WINDOW AREAS FROM THE THIN OXIDE METAL	CC000473	<	473
ρ	MTHN . NINT MTHN.C	CC000474		474
M		CC000475	<	475
1/1	CALCULATE JUNCTION CAPACITAN. S ASSUMING KA . 0.070 PF/SO,	CC000476	<pre><pre><pre><pre><pre><pre><pre><pre></pre></pre></pre></pre></pre></pre></pre></pre>	476
Н	MIL AND KP = 0.200 PF/MIL IN UNITS OF .001 PF	CC000477	<	477
Ε	6,EXP,-14285,-500	CC000478	<	478
М		CC000479	<	479
М	CALCULATE CROSSOVER CAPACITANCES ASSUMING KO = 0.000 PF/SQ.	CC000480	<	480
111	MIL THROUGH THICK EXIDE AND KB . 0.200 PF/SQ. MIL THROUGH	CCono481	<	481
19	THIN BXIDE IN .001 PF	CC000482	Canada Canada	482
R	PTHK = INTR EXPANTHK	CCono483	<	483
A	6,PTHK,-50000	CC000484	<	484
R	PTHN # INTR EXP,MTHN	CC000485	<	485
A	6.PTHN: -5000	CC000486	<	486
٤	PTHK,PTHN	CC000487	<	487
R	NTHK & INTR EXNIMITAL	CC000488	<	488
Α	6.NTHK50300	CC000489		489
R	MTHY = INTR EXAMTHN	CC000490	<	490
Α	6,NTHN,-5000	CC000491	<	491
.ε	NTHK, NTHN	CC000492	<	492
M		CC000493	<pre><pre><pre></pre></pre></pre>	493
		CC000494	<	494
'1	COEFFICIENTS	CC000495		495
2	ALL = PLUS EXPIEXN	CC000496	<	496
18	STHK = NINT MTHK/ALL	CC000497		497
EΑ	6.5THK50000	CC000498	<	498
: 2	STHN = NINT MTHN/ALL	CC000499	<	499
A	6, STHN, -5000	CC000500	<	500
	STHK, STHN	CC000501,		501
M		CC000502	<	502
ų _M	EQUATION GENERATION			503
. 11	4	CC000504	<	504
YM.		CC000505	<	505
-		CC000506	<pre><pre><pre></pre></pre></pre>	506
	- 11	CC000507		507
Ē	J . SAME PG	CC000508 "	<	508
: C	f2a1	CC000509		509
ĘŖ	NG . SAME NG	CC000510	<	510
) L	/6/PG:g/NG:1/PSD:PSD:PSM/NSD:NSD:NGM/	CC000511	<	511
M		CC000512	<pre><pre><pre></pre></pre></pre>	512
4.4	MISCELLANERUS LIST PROCESSING	CC000513	<	513
М		CC000514	<	514
111		CC000515	<	515
M	STORE DEVICE/NODE LIST	CC000516	<	516
SŢ	/6/PGM:PSD:PSD/NGK:NSD:NSD/	CC000517	<	517
МΜТ	PRINT LIST OF CHANNEL DIMENSIONS	CC000518	<	518
ΝG	6,0PC	CC000519	<	519
NG	6, CNC	CC000520		520

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FILES WHAT SET RECORDS 19TAL MANE TYPE MASKS NAME DIRECTORY FILE ADDRESS RECORDS IDENT# 1 IDENT# 2 W 10 1 U 1 1 2 N 12 3 500 2 1 2 N 12 3 500 1 1 3 C 14 4 500 1 1 4 5 H 15 6 1500 1 1 6 FINE								·: •						
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		8199	2100	0917		 -
	1 148 1 149	8292	5500	8747 8841	2300	
	1 150	838 <u>6</u> 8400	3300 5300	8934 8900	2400 <u></u> 7900	
	7 151 1 152	7700 8479	2400 2400	8100 9028	5000 250 0	
	8 153 _ 1 154	10700 8530	2400	11100	8400	
	155	8576	2500 2509	9079	2509 2600	
	1 156 1 157	8666 8752	2600 2700	8933 8835	2700 2783	
	7 158 3 159	1000	4500 6000	1400 9600	7100	
	9 160 3 161	7700 7500	6700	8100	7900 7500	
			8400	12800	8800	
		· · · · · · · · · · · · · · · · · · ·			i C	·
	3 111	1000	1700	1400	3400	
	3112113	4000 2500	1700 2500	4400 2900	3400 2800	
	1 114 7 115	5500 7700	2500 2500	5900	0085	
The same of the sa	\$ 116	10700	3200	8100 11100	4900 4200	
7	7 117 1 118	1000 5500	4600 5300	1400 5900	7000 6300	
S S	3 119 9 120	9200 7700	6100 6800	9600 8100	7800	·
	8 121	10700	6830	11100	7100 7100	
	3 3	100	1200		1 P	
	3 4	13175	1200	13100 13250	1400 1300	
	3 - 6 -	13125	1300 1400	13350 13450	1400 1500	
	3 7 38	100 100	1500	13550 13100	1600	
	3 9 3 10	13150	1600	13650	1800 1700	
	311	13250 100	1700 1800	13750 700	1890 3300	
	3 12 3 13	900 3900	1800 1800	1500 4500	5500 5500	· · · · · · · · · · · · · · · · · · ·
	3 14 3 15	6500 13350	1800 1800	7100	3300	
	3 16 3 17	13450 13550	1900	13850 13950	1900 2000	
	3 18	13650	2000	14050	2100	
	3 19 3 20	13750 13850	2300	_ 14250 14350	2300	
	3 21 3 22	13950	2400	14450	2400 2500	
	3 23	14050 14150	2500	14550 14650	2600 2700	-

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	·	1					May
	3	24	14250				
to the second	3	24 . 25	14350	2700 2800	14750 14850	2800 .	
to describe the second	3	26	900		1500	3300	
	3	27	3900	5900	4500	3300	
	3	8	14450	2900	14950	3000	
	10	2 9 30	7500	3000	8500	4400	
	- 8	31	8800	3000	10000	4400	
A Control of Section Control of the	3	35	14550	3000	11300 15050	4400	
	3	33	14650	3100	15150	3100	
	3	34	14750	3500	15150	3300 3500	
	3	35	100	3300	7100	3900	
The second of th	<u> </u>	36	14850	3300	15350	3400	
	3	37	14950	3400	15450	3500	
7 ·	· 	38	15050	3500	15550	3ñ00	
	3	39 40	15150	3600	15650	3700	
	3	41	15250 15350	3700	15750	3800	
	ă	42	15450	3800 3900	15850	3900	
	3	43	15550	4000	15950 16050	4000 .	
	3	44	15650	4100	16050 16050	4100	
	3	45	15650	4200 -	16050	4200 _ 4300 _	·
	3	46	15550	4300	16150	4400	
	3	47	15450	4400	16153	4500	·
0	3	48	15350	4500	16059	4600	
0.01 km $_{\odot}$. The contribution of 0.01 km $_{\odot}$ and 0.01 km $_{\odot}$.	ა ი	49	15250	4600	15963	4700	
D		50	15150	4700	15871	4800	
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						2 P	
	3	53	14850				
	ž	54	800	5000 5100	15589	5100	
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THE WARRY TO SERVICE AND RESIDENCE AND THE PROPERTY OF THE PRO	12	56	3600	5100	4800	6500	
	1	57	5100	5100	6100	6500 6500	
	3	58	14750	5100	15495	5200	
•	3	59	14650	5200	15401	5300	·
	3	60	14550	5300	15308	5400	
	3	61 62	14450 14350	5400	15214	5500	
	3	63	7700	5500	15121	F500	
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	3	65	7700	5700 5800	14934	5800	
	3	66	7700	5800 5900	14840 14747	5900	
	3	67	7700	6000	14700	6000	
and the second s	<u> </u>	68	9100	6200	9700	6600 6200	
	3	69	11700	6200	15300	7700 <u></u>	
	3	70	9100	7300	9700	7700	
	3	71	7000	7700	12300	8300	
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				, , un .	- 44-4		<u>i_</u>
			######################################			The second secon	-
	3	162	800	5500	1800	2900	
		.163 164	2100	5500	3300	2900	
	11	_165	5100	5500 5500	4800 6100	2600 2900	
	7	166	7200	5500	12100	5600	
A	· 3	167	5100	2600	6100	2900	
		168 169	7600 11700	2600	8200	2900	-
		170	7600	5900	12100	2900	
	1	171	11700	500	8200 12100	3300 3300	
	7 1	172	11700	3300	12100	4300	
Property of the second	71	173 _	100	4300	6900	4400	
	' ' '	174 175	11700 100	4300 4400	12100	4400	
		176	100 7600	4400 4400	6900 <u> </u>	4700	
	1	177	11700	#400 440Q	12100	4800 4800	
	7 1	178	100	4700	500	4800	
September 1 - Control of the Control	1	179	900	4700	1503	4800	
	7 .	180	6500	4700	6900	4800	-
		181	100 900	4800	500	5:00	
	71	183	6500	4800 4800	1500 12100	5100 5100	-
	7 1	184	100	5100	500	5100 5200	
	71	185	6500	5100	12100	5200	•
	7	186	100	5200	500	6500	
10	7;	187 188	6500 100	5200	6900	6500	
	71	189	900	6500 6500	500 1500	6600	
	7 1	190	6500	6500	6900	6600 6600	
	1	191	100	6600	500	6900	
	7 ;	192	900	6600	1500	6900	
		193 194	6500 7500	6600	6900	6900	
	31	195	7500 8800	6600 6600	8500 10000	6900	
	8 1	196	10300	6600	11200	6900 6900	
	1	197	100	6900	6900	7300	
		198	7500	6900	8500	7300	
		199 200	8800 10300	6900	10000	7300	·
. DIRECTORY .	<u>.</u>	30 	10300	6900	11200	7300	·
FILES							
UNIT SET RECORDS TOTAL NAME TYPE						— ·-·	_
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MASKS	••••					APPENDIX 4 1 1997 - 100 1001, 5 th sector 100 100 100 100 100 100 100 100 100 10	
NAME DIRECTORY FILE ADDRESS RECORDS IDENT # 1	1 IDENT # 2						^
M 11 2 3300 1 9	9 161						
12 3 6300 1 110 C 13 4 9300 1	04				-		_
N 15 6 15000 1 9	9 200		——————————————————————————————————————				
16 7 18300 1 2					1		
P 17 8 21600 2 12					,		
+ TIME +		~~~~					
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性影響 医克萨氏菌 医乳球毒素 化基础 计模型 计分类 人名法

C-1

Output for commands 57 through 89 not shown.

		WITHER TATELS OF SUITE STATE AND LOS	CC000090	
STER PA * NENK PAH # WARNING #	LINE LINE	N INTO ACTIVE OR GUARD BAND AREAS CCODO092	CC000091	92
# WARNING # cendition 8				
CONDITION 8 # WARNING # CONDITION 3				
NULL MASK				
and the second s			e de la Caracteria de l	, <u></u>
				1 PA

			<u></u>		· server
			E 175 C. MARIN WAS TO MAKE AVE. 1995	M-4100-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-	
	1 7	1 5100 77500	5100	6100	6500
	7	7 800	3000 5100	8500 1800	4400 6500
		8 10300	3000	11300	4400
	11	10 8800 11 2100	3000 5100	10000	4400 6500
+ DIRECTORY +	12	12 3600	5100	4800	6500
FILES				· · · · · · · · · · · · · · · · · · ·	
UNIT SET RECORDS TOTAL NAME TYPE 5 32 6 934 MTSE 1					
MASKS NAME DIRECTORY FILE ADDRESS RECORDS	IDENT # 1 IDENT # 2				
M 11 2 3300 1	9 161				
PA 12 3 6000 1 C 13 4 9300 1	9 121				
N 15 6 15300 1	99				
7 16 7 18300 1 P 17 8 21600 2	16 110 12 71				<u> </u>
W 18 9 24300 1	11 2				
					** ***********************************
→ TIME ★			CLBCK #	147	
Outp	ut for commands 93 th	rough 94 not sh	DELTA =	163 	
Outp	ut for commands 93 th	rough 94 not sh	DELTA =	2	
Outp	ut for commands 93 th	rough 94 not sh	DELTA =	2	95
Outp	ut for commands 93 th		DELTA =	2	95
Outp		CC000095	DELTA s	2	••• 95 1 PG
Outp	3 3	CC000095	DELTA *	13100 13250	95 1 PG
Outp	3 3 3	CC000095 3 100 4 13175 5 13125	1200 1200 1300	13100 13250 13350	1 PG 1400 1300 1400
Outp	3 3 3 3 3 3	CC000095 3 100 4 13175 5 13125 6 100 7 100	DELTA *	13100 13250 13350 13450	1 PG 1400 1300 1400
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Outp	3 3 3 3 3	3 100 4 13175 5 13125 6 100 7 100 8 100 9 13150	1200 1200 1200 1300 1500 1500 1600	13100 13250 13250 13450 13550 13100 13650	95 1 PG 1400 1300 1400 1500 1600 1800 1700
Outp	3 3 3 3 3 3 3 3	3 100 4 13175 5 13125 6 100 7 100 8 100 9 13150 10 13250 11 100	1200 1200 1200 1300 1400 1500 1600 1700 1800	13100 13250 13250 13450 13550 13100 13650 13750	1 PG 1400 1300 1400 1500 1600 1800 1700 1800
Outp	333333333333333333333333333333333333333	3 100 4 13175 5 13125 6 100 7 100 8 100 9 13150 10 13250 11 100 12 900	1200 1200 1200 1300 1400 1500 1600 1700 1800 1800	13100 13250 13350 13450 13550 13100 13650 13750 700	1 PG 1400 1300 1400 1500 1600 1700 1800 3300 2200
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Outp	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	3 100 4 13175 5 13125 6 100 7 100 8 100 9 13150 10 13250 11 100 12 900 13 3900	1200 1200 1200 1300 1400 1500 1600 1700 1800 1800	13100 13250 13350 13450 13550 13100 13650 13750 700	1 PG 1400 1300 1400 1500 1600 1700 1800 3300 2200

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to a final community of the second contract o	3 16	13450	1900	13950	2000
	3 17	13550	2000	14050	2100
The second secon	3	13650	2100	14150	2200
	3 19 _3 20	13750 13850	2200	14250	2300
	3 21	13950	2300 2400	14350 14450	2400
	3	14050	2500	14550	2500 2500
	3 23	14150	2600	14650	2700
	3 24	14250	2700	14750	2800
	3 25 3 26	14350 900	2800	14850	2900
	3 27	3900	8900	1500 4500	3300
As are a second country to the second countr	3 28	14450	2900	14950	3300 3000
	3 32	14550	3000	15050	3100
	3 33	14650	2100	15150 📜	3200
	3 34 _335	14750 100_	3200	15250	3300
	3 36	14850	3300	7100 15350	3900
and a transfer production and production control of the control of	3 37	14950	3400	15450 15450	3400 3500
	3 38	15050	3500	15550	3600
19 of a residency with your to read and the property of the state of t	.3	15150	3600	15650	3700
	3 40 _341	15250 15350	3700	15750	3800
	3 42	15450	3800 3800	15850 15950	3900
The state of the s	3 43	15550	4000	16950	4000 4100
	3 44	15650	4190	16050	4200
per demonstrating a second of the control of the co	. 3	15650	4200	16050	4300
	3 46 3 47	15550 15450	4300	16150	4400
	3 46	15350	4400 4500	16153 16059	4500
The state of the s	3	15250	4620	15965	4600 4700
	3 50	15150	4700	15871	4800
	351	15050	4800	15777	4.000
	3 52 3 53	14950 14850	4900	15683	5000
	3 58	14750	5000 5100	15589	5100
ing in the state where the state is a state of the state	3 59	14650	5200	15495 15401	5209 5300
					5300
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					2 Pg
	3 60	14550	5300	15308	5,00
The same a second during his difference and the second difference and	361	14450	5400	15214	5400 5500
	3 65	14350	5500	15121	5600
The state of the s		7700	5600	15027	5700
	3 64 3 65	7700 7700	5700 5800	14934	5800
	3 66	7700	5900 5900	14840 14747	5900
The second of th	3 67	7700	6000	14705	6200 6000
	3 68	9100	6200	9700	6600
The second secon	3 69	11700	6200	12300	7700
	3 70 3 71	9100 7000	7300 7700	9700	7700
• DIRECTORY • FILES			7744	12300	8300
Figure and the second s					
					F =

TOTAL NAME TYPE RECORDS 12 MASKS NAME ADDRESS M PA C PG 0.400 â CLOCK . DELTA . Output for commands 96 through 98 not shown. SEPARATION OF N DIFFUSION INTO ACTIVE OR GUARD BAND AREAS CC000099 _CC000098_ PPER NA . INTR NAW 5100 10. 11 10300 8500 750C

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	本外的社会的对象的对象的		1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1		and the second section of the second		ACT OF THE PROPERTY OF THE PRO		real compositive program is really the second second second second second second second second second second s
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·									
. DIRECTORY	•								
FILES UNIT	SET RECOR!	OS TOTAL NAT	1F TYPE	•	•				
5	36 67	7 1092 PG	1		Visit a new a seriespepa		+		
MASKS NAME	DIRECTORY	FILE ADDRES	RECORDS ID	ENT 4					
NA M	10 11	1 4)	ENT # 1 IDENT	11	- 			
PA	12	3 6300 S 3300)	12	161				- · · · · · · · · · · · · · · · · · · ·
<u>C</u> P6	13	4 5300 5 18600) 2	9 3	_121 71				
N	15 16	615300 7]	9 16	200			·	THE REAL PROPERTY AND ADDRESS OF THE PROPERTY ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY AND ADDRESS OF THE PROPERTY ADDRESS
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			Output	for comman	ds 99 thro	ugh 101 not	shown.		
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PER NG . N	INT NAME				cc	000102	<		02
	n was stated and a second					n errer vanden	ek beresa ara		
			1.				The second secon		NG
	100				166 168	7200 7600	26001	2100 2600 8200 2900	
				 7 ··-	169 170	11700 7600	26001	2100 2900	
					171	11700	<u> 2900 1</u>	00EE001S	
<u> </u>					172 173	11700	3300 1: 4300	2100 . 4300 6900 4400	

. TIME .

NG -

CLOCK # 174 DELTA # 1 Output for commands 33 through 149 not shown.

				P TRANSIST	BR IDENTIF	ICATION / CHE	EÇK <u>ING</u>			CC000150 CC000151		
		·	THAT METAL	ANY CHANNE L AND THIN	EL UP TO 1	P CHANNELS, A MIL LONG WIT L PERFORM SOM	TH AT L Mewhat	EAST 0-1 MIL Like A Trans	Ľ.	CC000152 CC000153 CC000154 CC000155 CC000156		*
9	PER PPC . TI	WIX PA	S10# 1,R230,S ² 3 DIFF	<u>1# 1</u>			CC	000157 000158	<-====================================	***********	157 158	
+	NULL MASK *	·		· · · · · · · · · · · · · · · · · · ·			- 					
<u> </u>				<u></u>			. recipie man com	e a annua guesa silvegara se e a serie da cere e dasse e susciencia .				
	WARNING # CONDITION 8											
	CANDITION 8				·							

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	•				•	1 2	1 2	8500 10000	3000	8800 10300	· 4400 4400	
.:	· · · · · · · · · · · · · · · ·					3	3	1800	5100	2100	6500	—
						5	4 5	3300 4800	5100 5100	3600 5100	6500 <u></u>	
	DIRECTORY •											
1	UNIT SE		RDS TOTAL NAME 41 1366 SURE							A	t i 2 ft - MMS shi yari wisatsahan	
- ,	MASKS NAME DI	RECTORY	File ADDRESS	RECORDS	IDENT # 1	IDENT # 2		· · · · · · · · · · · · · · · · · · ·		*		 -
	NA	10	1 1,00	1	9	11			/			
***	PA	11	0069 E 3300	1	12	161 12						
	C PG	13	4 9900 5 12,10		9.		/			-		
	N N	15	6 15300	1	9	200_				·		
	T P	16 17	7 18300 8 21600		16 12	110 71				•		
	H NG	18	9 24300	1	11	5	************				and well-dark of the complete larger and the complete	-
	NG PPC	53	10 27300 14 39000		5	197 5			• • • • • • • • • • • • • • • • • • •		a or an area experienced and a second	
	TIME +		*						CLOCK .	214		

VL PPC.97			
EC MINAMIOO	CC000159 CC000160	<pre></pre>	159 160
R PC = INTR PPCAT	CC000161	<	161
DIRECTORY .		-	
FILES UNIT SET RECORDS TOTAL NAME TYPE			* * · · · · · · · · · · · · · · · · · ·
5 46 41 1366 SURE 1			
2 40 41 1000 30-12 1			
MASKS			
NAME DIRECTORY FILE ADDRESS RECORDS IDENT # 1 IDEN			
M 11 2 3300 1 9	11		
PA 12 3 6300 1 12	161	rene validades (d. 19. 19. 19. 19. 19. 19. 19. 19. 19. 19	· ———————
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PG 14 5 12600 2 3	71		
N 15 6 15300 1 9	200	en en manuel de seus mentres de seus de seus de seus de seus de seus de seus de seus de seus de seus de seus de	
T 15 7 18300 1 16 P 17 8 21600 2 12	110		
W 18 9 24300 1 11	7 <u>1</u> 2		
NG 19 10 27300 1 7	197		
PPC .23 14 39300 1 5	5		· · · · · · · · · · · · · · · · · · ·
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後 節数 章		CLACK + DAK	
		CL8CK * 216	
IME •		DETIN + S CFBCK + STE	
· 1		DEFLY * 5 CF8CK * 516	
C MINA+100	CC000162	DEFLY * 5 CFBCK * 516	142
C MINA 100 R PC = INTR PC.M	CC000162 CC000163	CFBCK * 516	162
C MINA+100 R PC = INTR PC+M	CC000163 CC000162	<	162 163
C MINA 100 R PC = INTR PC = M PRECTURY = FILES	CC000163	<	162 163
C MINA 100 R PC = INTR PC = M	CC000162 CC000163	CLBCK * 516	162 163
C MINA 100 R PC = INTR PC = M PRECTURY = FILES UNIT SET RECORDS TOTAL NAME TYPE 5 46 +1 1366 SUME 1	CC000163 CC000163	CLOCK * 516	162 163
C MINA 100 R PC = INTR PC # PIRECTORY • FILES UNIT SET RECORDS TOTAL NAME TYPE 5 46 41 1366 SUME 1	CC000163	<	162
C MINA-100 R PC = INTR PC+M PRECTHRY + FILES UNIT SET RECORDS TOTAL NAME TYPE 5 +6 +1 1366 SUME 1 MASKS NAME DIRECTORY FILE ADDRESS RECORDS IDENT # 1 IDEN	CC000163	<	162
C MINA-100 R PC = INTR PC.M IRECTBRY = FILES UNIT SET RECORDS TOTAL NAME TYPE 5 46 +1 1366 SURE 1 MASKS NAME DIRECTORY FILE ADDRESS RECORDS IDENT # 1 IDEN NA 10 1 300 1 9 M 11 2 3300 1 9	CC000163	<	162 163
C MINA-100 R PC = INTR PC+M IRECTURY = FILES UNIT SET RECORDS TOTAL NAME TYPE 5 +6 +1 1366 SUME 1 MASKS NAME DIRECTORY FILE ADDRESS RECORDS IDENT # 1 IDEN NA 10 1 300 1 9 M 11 2 3300 1 9 PA 12 3 6300 1 12	CC000163	<	162 163
C MINA-100 R PC = INTR PC+M IRECTURY = FILES UNIT SET RECORDS TOTAL NAME TYPE 5 +6 +1 1366 SURE 1 MASKS NAME DIRECTORY FILF ADDRESS RECORDS IDENT # 1 IDEN NA 10 1 300 1 9 M 11 2 3300 1 9 PA 12 3 6300 1 12 C 13 4 9300 1 9	CC000163	<	162 163
C MINA*100 R PC = INTR PC*M IRECTBRY * FILES UNIT SET RECORDS TOTAL NAME TYPE 5	CC000163	<	162
C MINA*100 R PC = INTR PC*M IRECTBRY * FILES UNIT SET RECORDS TOTAL NAME TYPE 5 46 41 1366 SURE 1 MASKS NAME DIRECTORY FILE ADDRESS RECORDS IDENT # 1 IDEN NA 10 1 300 1 9 M 11 2 3300 1 9 PA 12 3 6300 1 12 C 13 4 9300 1 9 PG 14 5 12600 2 3 N 15 6 15500 1 9	CC000163	<	162
C MINA*100 R PC * INTR PC*M PRECTURY * FILES UNIT SET RECORDS TOTAL NAME TYPE 5 46 +1 1366 SUME 1 MASKS NAME DIRECTORY FILE ADDRESS RECORDS IDENT # 1 IDEN NA 10 1 300 1 9 H 11 2 3300 1 9 PA 12 3 6300 1 12 C 13 4 9300 1 9 PG 14 5 12600 2 3 N 15 6 15000 1 9 T 16 7 18000 1 9 T 16 7 18000 1 9	CC000163	<	162
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Output for commant 67 through 195 not shown.

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Output for commands 202 through 218 not shown.

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Output for commands 225 through 253 not shown

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SPEC MAXW=1000,Rin0,S18	METAL AND THIN BXIDE WILL PERFORM	M SOMEWHAT LIKE A TRANSIS CC000862	TBR CC000261	262
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Output for commands 272 through 300 not shown.

LOCATION OF N SOURCES AND DRAINS

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SPEC_R180.S15# 1 SPER_NSD = SAME NA		CC000303 CC000304	<	
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Output for commands 307 through 323 not shown.

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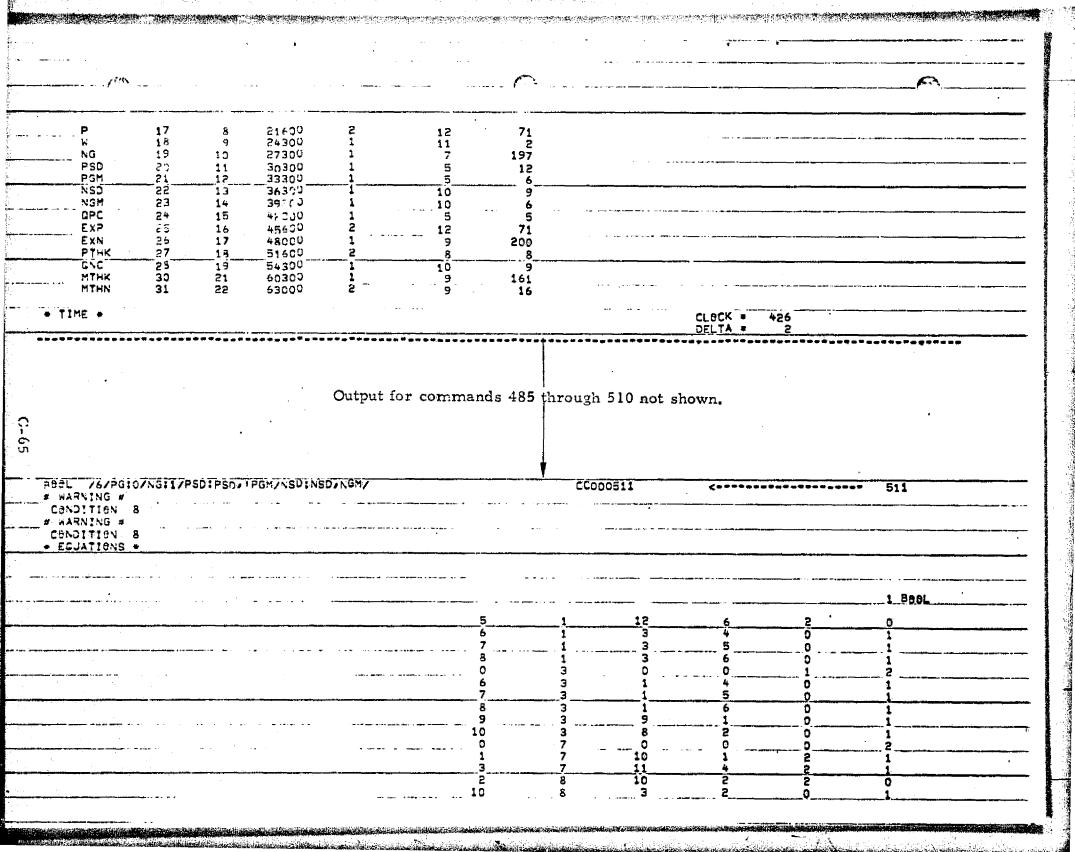
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NG 14 5 12300 1 N 15 6 15300 1	7		
7 16 7 18300 1	9 200 <u> </u>		
P 17 8 21600 2 W 18 9 24300 1	127 <u>1</u> 11 2		
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APPENDIX D

ROUTINES CALLING STRUCTURE

This appendix presents the routines calling structure of MAP. Table D-1 lists each inline main program routine with the other inline routines and the subprograms which each may call. Table D-2 lists each subprogram with the other subprograms each may call.

INLINE ROUTINES CALLING STRUCTURE

			Ī	
CALLING ROUTINE	INLINE RO	UTINES CALLED	SUBPROGR	AMS CALLED
INIT			102 103 107	108 DEPEND LOCATN
ORTHO -			OP1 SMASH 107	BOOK1 BOOK2
COMMIE	COMM FILE TEXT FREE OPER SPEC TRAC BOOL	LIST AREA PERI PARE RANG SKIP IFNL	102 107 108	BOOK2 LOCATN
FINIT			107	
COMM			107	
FILE			OP1 103 106A 106B	106C 106D BOOK1
TEXT			OP1 103 106A 106B	106C 106D BOOK1
FREE			103	BOOK2
OPER	SAME NGTV EDGE EXPN PLUS INTR NINT EXOR LINK1	NLNK TWIX1 TWIX2 SPIN FLIP PUSH SCAL WNDW PLAC	103 103	BOOK1 GEOM

Table D-1

INLINE ROUTINES CALLING STRUCTURE (continued)

CALLING ROUTINE	INLINE ROUTINES CALLED	SUBPROGRAM	S CALLED
SPEC		103 108	BOOK1
TRAC	LINK1	OP1 OP2 OP3 OP4	102 103 BOOK1 BOOK2
BOOL		OP1 / OP2 OP3 102 103	106A 107 BOOK1 BOOK2
LIST		OPI OPZ OP3 102 103	106A 107 BOOK1 BOOK2
AREA		103 103 104	107 BOOK1
PERI		OP1 103 106A	I07 BOOK1
PARE		OP1 103 106A	107 BOOK1
RANG		OP1 103 106A	BOOK1

Table D-1 (continued)

INLINE ROUTINES CALLING STRUCTURE (continued)

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AT .

	 		·	
CALLING ROUTINE	INLINE ROU	TINES CALLED	SUBPROGRA	AMS CALLED
SKIP			102	103
IFNL	SKIP		103	BOOK1
SAME			OPI	-
NGTV	NINT		105	BOOKI
EDGE	·		OP1 OP4	BOOK1
EXPN			OP1	
PLUS	,		OP1	OP2
INTR			OP3	
NINT			OPl	OP4
EXOR	NINT	PLUS	BOOK1	
LINK1			OPI OP3 OP4	BOOK1 BOOK2
LINK2	LINK1		OP1 OP3	BOOK1
NLNK	LINK1		OP1 OP3	OP4 BOOK1
TWIX1			OPl OP2 OP4	BOOK1 BOOK2 GEOM
TW1X2	TWIX1		OP2	BOOK1

Table D-1 (continued)

INLINE ROUTINES CALLING STRUCTURE (continued)

CALLING ROUTINE	INLINE ROUTINES CALLED	SUBPROGRAMS CALLED
SPIN	,	OPl
FLIP		OPl
PUSH		OPI
SCAL		OPl
WNDW		OPl
PLAC		OP3

Table D-1 (continued)

SUBPROGRAMS CALLING STRUCTURE

CALLING SUBPROGRAM	SUB	PROGRAMS CA	LLED
OPI	104 105 ORDER1	ORDER2 ORDER3 ORDER4	LOCATN
OP2	I04 I05 ORDER1	ORDER2 ORDER3 ORDER4	LOCATN
OP3	104 105 ORDER1	ORDER2 ORDER3 ORDER4	LOCATN
OP4	104 105 ORDER1	ORDER2 ORDER3 ORDER4	BOOK1 BOOK2 LOCATN
SMASH	IO1 IO1A IO1B	I01 C I01 D I01 E	105
I01	LOCATN	DEPEND	
I01A	108	LOCATN	DEPEND
I01B	108		
I01C	108		
101D		*********	
I01E	108		
102	Ĭ08		
103	108		
I04	108	DEPEND	LOCATN
105	106A 106B 106C	106D 107 108	LOCATN DEPEND

Table D-2

SUBPROGRAMS CALLING STRUCTURE (Continued)

CALLING SUBPROGRAM		HDDDOCD AME CALLED
OADLING SUBFROGRAM	 	UBPROGRAMS CALLED
106A	107	108
I06B	108	
I06C	108	
I06D	108	DEPEND
CALLING SUBPROGRAM	s	UBPROGRAMS CALLED
107	DEPEND	
108		
ORDER1	ORDER2	
ORDER2	105 107	ORDER5 LOCATN
ORDER3	I04 I05	ORDER5 BOOK1
ORDER4		
ORDER5		
BOOK1	108	
BOOK2	LOCATN	
GEOM	OP1 OP4	105 BOOK2 BOOK1
DEPEND		
LOCATN		

Table D-2 (Continued)

APPENDIX E

DESCRIPTIONS OF PROGRAM VARIABLES

This appendix presents descriptions of MAP variables. Further knowledge of the variables may be gained from the liberal comments found in the MAP Source Listing.

Table E-1 presents each variable name and a brief definition. All variables are integer type unless otherwise noted. All are in blank common or equivalent to blank common variables unless identified as local. Equivalence is indicated by "variable = variable." Arrays are listed subscripted by their dimension. A subscript of "I" indicates the array dimension may be varied for different versions of the program.

VARIABLES DEFINITIONS

VARIABLE	DESCRIPTION
AL .	Alternate command input logical unit number: AL = NUM1(4).
AP(24)	Real I01B local variable containing line widths for type 1 input data format.
BEG(8)	Index to LIST array for the beginning of each list segment.
BEGO(3)	Index to LIST array for the beginning of each ordered list.
В1	Single blank character.
B4	Real scalar containing four blank characters.
C(15)	Real MAIN local array containing the 4-character command names.
CARD(76)	Command image buffer storing columns 5-80.
CELL	Local IOTE scalar containing a cell identifier from type 4 input data.
CHAR(11)	Local I06D array containing type 3 character design file entry words.
CHARAC	Number of characters which can be stored in word.
CONI	Real MAIN local variable containing the characters "OPTN".
CON2	Real MAIN local variable containing the characters "MASK".
COUNT(I)	Each entry is a count of records input or output for the mask occupying file location I.
CR	Normal command input logical unit number. CR = NUM1(1).

Table E-1

VARIABLES DEFINITIONS (Continued)

VARIABLE	DESCRIPTION
D(7)	Local IO3 array containing single characters considered delimiters on command records.
DATA(12)	Dummy array for temporary storage of output items: DATA(12) = last word of LIST.
DATA1 - DATA12	Scalar values for DATA array items: DATA1 = DATA(1).
DELIM(36)	Contains an index to D array for each delimiter preceding a valid field on a command image.
DESTIN	Four-character mask destination name.
DIG(11)	Local I06D array used for storing identifier digits for output as type 3 character definitions.
DIREND	Length of directory, i.e., upper bound for NAME, NUM1, NUM2, COUNT, and RECORD arrays.
DX1, DX2, DY1, DY2	Local SMASH scalars used for storing delta x and y values during smashing.
END(8)	Index to LIST array for the end of each list segment.
ENDO(3)	Index to LIST array for the end of each ordered list.
ENTRY(6)	Contains the priority of words considered when ordered lists are created.
FACT1 - FACT4	Factors used in the formula to calculate many file record addresses.
FIELD (34)	Real array containing the valid fields located on a command image.
FILE(8)	Contains the file position of the masks associated with each LIST segment at any time.
FPX, FPY	Local I01E scalars containing polygon first point coordinates from type 4 input data.
I	Widely used local dummy scalar variable.

Table E-1 (Continued)

VARIABLES DEFINITIONS (Continued)

VARIABLES

DESCRIPTION

IN

Graphic input data logical unit number: IN = NUM1(2).

INP1

File position of primary input mask.

INP2

File position of secondary input mask.

ITEMS

Number of six-word items per list segment.

J

Widely used local dummy scalar variable.

k

Widely used local dummy scalar variable.

L

Widely used local dummy scalar variable.

LARGE

Largest positive integer value.

LAST

Four-character name of the previously processed

command: LAST = NAME(2).

LEND

Length of COMMON from BEG(1) through DATA12.

LENGTH

Record length in words for special list output.

LIST (I)

Main list for processing mask data.

LOC(9)

Index to LIST array for the current processing location for each list segment.

LOCO(3)

Index to LIST array for the current processing

location for each ordered list.

LP

Printer formatted output logical unit number:

LP = NUM1(3).

LPX, LPY

Local 101E scalars containing polygon last point

coordinates from type 4 input data.

M

Widely used local dummy scalar variable.

MACHIN

Number of bits per word.

Table E-1 (Continued)

VARIABLES DEFINITIONS (continued)

VARIABLES

DESCRIPTION

MASK

Four-character mask name.

MAXIM(6)

Maximum specified dimensions in the x, y, length, width, radial, or any directions: MAXIM(1) = MAX1.

MAX1 - MAX6

Scalar values for MAXIM array items.

MINIM(6)

Minimum specified dimensions in the x, y, length, width, radial, or all directions:

MINIM(1) = MIN1.

MIN1 · MIN6

Scalar values for MINIM array items.

MODE

General processing mode.

MODEL

Processing mode for subroutines IOI, IOIA, IOIB.

101C, 101D, and 101E.

MODE2

Processing mode for subroutine 102.

MODE3

Processing mode for subroutine 103.

MODE4

Processing mode for subroutine 104.

MODE5

Processing mode for subroutine 105.

MODE6

Processing mode for subroutines 106A, 106B,

106C, and 106D.

MODE7

Processing mode for subroutine 107.

MODE8

Processing mode for subroutine 108.

MU

Logical unit number for the mask storage file.

N

Widely used local dummy scalar variable.

Table E-1 (continued)

VARIABLES DEFINITIONS (continued)

VARIABLES

DESCRIPTION

NAME(I)

Real array where each entry is the 4-character name for the mask occupying file location I.

NEXT

Indicator of additional steps in a string of processes.

NUM1(I)

Each entry contains the greatest primary identifier of the mask occupying file position I.

NUM2(I)

Each entry contains the greatest secondary identifier of the mask occupying file position I.

NXT

ORDER2, ORDER3, GEOM, and OP4 local storage of the scalar NEXT.

O(22)

Real MAIN local array containing the 4-character OPER command names.

OPTION(30)

Array encompassing a group of scalars: OPTION(1) = OPTN1, OPTION(30) = SEQ10.

OPTNL

Print option value.

OPTN2

Alternate input unit option.

OPTN3

Data mode option.

OPTN4

Scale factor option.

OPTN5

Offset override option.

OPTN6

Smash factor option.

OR

Value indicating list ordering priority pattern.

ORD

Ordered list segment length.

ORX, ORY

Local 101E scalars containing cell origin coordinates from type 4 input data.

OUT1

Mask output file position.

Table E-1 (Continued)

VARIABLES DEFINITIONS (continued)

VARIABLES	DESCRIPTION
OUT2	Ordered mask output file position.
OUT3	Special list output logical unit.
OUT4	Printed output logical unit.
OUT5	Mask output file position.
P	Widely used local dummy scalar variable.
PARAM(8)	Real local I01B array storing parameters of type 1 input data prior to smashing.
PASS	Pass counter for multiple pass processes: PASS = NUM2(2).
PATI	Path code for overall operations.
PAT2	Path code for a specific operation step.
PAT3 - PAT5	Miscellaneous path flags.
POINT(12)	Real local IOIB array storing type 1 input data coordinates prior to smashing.
POINT(4)	Real local IOIC array storing type 2 input data coordinates prior to smashing.
POINT(4)	Real local I01D array storing type 3 input data coordinates prior to smashing.
P1 - P4	Real local 101E scalars storing type 4 input data coordinates prior to smashing.
P1 - P6	Real local IOID scalars storing type 3 input data coordinates prior to smashing.
P5 - P8	Real local 101C array storing type 2 input data coordinates prior to smashing.
Q	Widely used local dummy scalar variable.
R	Widely used local dummy scalar variable.

Table E-1 (Continued)

VAR!ABLES DEFINITIONS (Continued)

VARIABLES	DESCRIPTION
REAL1 - REAL2	Real scalars local to OP1 and OP4 used to store floating point numbers resulting from mathematical operations.
RECORD(!)	Each entry contains a record count for the mask occupying file position I.
S(35)	Real MAIN local array containing the 4-character SPEC command forms.
S(36)	Local 106D array containing default information for the first record of a design file.
SCALE	Real local IO1E scalar storing type 4 input data scale
SEG	General list segment number.
SEG1	Primary input mask list segment number.
SEG2	Secondary input mask list segment number.
SEG3	Unordered mask output segment number.
SEG4	Ordered mask output segment number.
SEG5	Residue list segment number.
SEQ1	Preliminary identifier action code.
SEQ2	Final primary identifier action code.
SEQ3	Final secondary identifier action code.
SEQ4	Index to LIST array of identifiers to be considered for modification.
SEQ5	Primary identifier incrementing value.
SEQ6	Secondary identifier incrementing value.
SEQ7	Previous primary identifier replaced.
SEQ8	Previous secondary identifier replaced.
	Table E-1 (Continued) E-8

VARIABLES DEFINITIONS (Continued)

(Continued)		
VARIABLES	DESCRIPTION	
SEQ9	Previous primary replacement identifier.	
SEQ10	Previous secondary replacement identifier.	
SETEND	Upper bound on SETUP array.	
SETUP(I)	Array used to store information for multiple step processes.	
SET1 - SET5	Scalar values for first five entries of SETUP arrays: SET1 - SETUP(1).	
SKIP	Record skip flag for reading mask input data.	
SPEC(5)	Array form of specification codes: SPEC(1) = SPEC1	
SPEC1	Printed output specification code.	
SPEC2	Temporary storage specification code.	
SPEC3	Identifier assignment specification code.	
SPEC4	Minimum dimensional boundary specification code.	
SPEC5	Maximum dimensional boundary specification code.	
START	Address of first entry in an ordered list.	
STAT	General I/O status flag.	
STATE	Real 107 local array containing "ON" and "OFF" for Boolean printout.	
STATUS(8)	Contains the I/O status of each list segment.	
STRING(3)	Real 103 local array into which valid field command characters are encoded.	

Real MAIN local array containing the 4-character names of operation options.

Table E-1 (Continued)

T(10)

VARIABLES DEFINITIONS (Continued)

VARIABLES	DESCRIPTION
TEMP(12)	103 local array used to temporarily store command image characters.
TEST	Indicator for dimensional testing steps in a process string.
TIME	DEPEND local real scalar storing internal clock time.
TYPE	Real 4-character command type.
T1, T2	Local 101E scalars containing characters identifying valid type 4 format input records.
T1 - T6	Real I01B local scalars containing four characters identifying valid type 1 format input records.
UNIT	Mask file position indicator.
VALUE(6)	Miscellaneous values storage: VALUE(3) - VALUE(6) contain coordinates of the permissible window of masks for the run: VALUE(1) = VAL1.
VAL1 - VAL6	Scalar names for VALUE array items.
WORDS	Number of words in a list segment.

Table E-1 (Continued)

"9" and "-".

Local IOIC scalar containing the character "X".

Local IO3 array containing the characters "O" -

X

Z(11)